

SCIENCE

VOL. 93

FRIDAY, JANUARY 31, 1941

No. 2405

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa.

Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, \$6.00

Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

SCIENCE VERSUS LIFE¹

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I AM grateful for the honor and conscious of the responsibility of speaking to you on this occasion. Many of you are probably disappointed that my theme is not one in which I may claim special experience and competence. But I felt that this is not the time and place to display one's personal wares, the special minutiae of our common endeavor. I have chosen the harder way of thinking aloud, perhaps neither wisely nor well, on a problem of deep concern to all scientists and all other citizens. In so doing it may be that the apparent urgency of the problem obscured the factor of personal incompetence. But I assure you that this eclipse is not total. Should I bore my seniors, seniors in experience, wisdom and years, may I suggest that

perchance there is a precipitate, even from folly; and should I exasperate our "young men in a hurry," may I remind them that the general education of the scientist-citizen is incomplete, even at the age of three-score and ten.

When the hurricane strikes ships at sea, frail hulls founder, while the crew of sturdier crafts experience anxiety, if not panic, and are for a time deflected from their course by the temporary violence of wind and waves. But they ultimately make their goal, thanks to human courage, the compass and the fixed stars. Such hurricanes, man made, have struck human society, and its institutions, from time to time throughout recorded history. We call them war. The world is now in the midst of one such period of violence, labeled "the worst"; because human memory is short, and even yesterday's experience is less vivid than that of to-day.

¹ Annual lecture under the auspices of Sigma Xi and in cooperation with the American Association for the Advancement of Science, Philadelphia, December 30, 1940.

There is anxiety and fear, if not panic on board. When storm clouds cover the heavens men of little understanding question the compass of science, fear that the stars of rectitude will guide no more, and with scant hope drift with the violent wind. The compass of science is not only questioned, but it is charged that this very compass has led us into the hurricane, that science is in conflict with society. So I propose to address myself to these questions: Is our age led or dominated by science? Is science in conflict with the best interest of society? Is it science and the scientific method that lead nations into war? Only last year a British scholar said: "In Europe to-day it is rather dangerous to ask questions, it is much safer to discuss how a question should be asked." To-day this danger is by no means confined to Europe. But as I read the human record in mud, and rocks, and ancient ruins, on tablets of clay, in scratches on stones, papyrus and paper, I think I discern evidence of *the ascent of man*, through asking all kinds of questions at all times, and seeking the answers by the best methods of the age. If we do less, we admit that science and civilization is a blind alley in human evolution.

Is ours the Age of Science? Or rather, in what sense is ours the Age of Science? An eminent physicist recently said, in this very city (Philadelphia): "In no previous time in human history has life and thinking been so greatly influenced by science as it is to-day." This is undoubtedly true, but does that alone make ours the Age of Science? I think not. Those who, accusingly or proudly, describe our times as the Age of Science usually cite as evidence the modern aspects of man's inhumanity to man or the numerous practical applications of the discoveries in physics, chemistry, geology, biology and medicine during the last hundred years, such as the steam and gas engines, the telegraph, the telephone, the airplane, the radio, modern surgery, fair control of infectious disease, modern sanitation and many other inventions and measures that contribute to the convenience, the efficiency, the health, the comfort and the happiness of modern life. It is true that science has, during the last hundred years, increased enormously our understanding of the nature of the world and the nature of man, and with that greater understanding has come greater control of the forces that act in man and in his environment. But fundamental discoveries in science are the achievement of but a few people. The practical inventions based on these discoveries are also the work of a few men, relatively speaking. And the physical and chemical inventions are mostly gadgets that merely modify our tempo and external mode of living. I contend, and I think I will be able to prove to you, that the great mass of the people of our age, the rank and file of men and women of our day, even in the most enlightened countries, in their thinking and in their motivation are

nearly as untouched by the spirit of science and as innocent of the understanding of science as was the "Peking Man" of a million years ago. The modern man adjusts to an environment greatly modified by the scientific efforts of the few. The "Peking Man," we may assume, adjusted himself as best he could to nature in the raw. A span of about a million years separate the two. And yet the two are about equally innocent of science, in the sense of the spirit and the method of science as part of their way of life. For science is more than inventions, more than gadgets, however useful and important they be. Science is even more than the discovery of and correlation of new facts, new laws of nature. The greatest thing in science is the scientific method, controlled and rechecked observations and experiments, objectively recorded with absolute honesty and without fear or favor. Science in this sense has as yet scarcely touched the common man or his leaders. The character of human society in any age is determined by man's thinking, motivation and behavior rather than by external gadgets. The erroneous assumption that ours is the Age of Science, or the very limited sense in which this is true, has led many people to charge to science some of the follies and failures, some of the violence, the brutalities, the suffering, the confusion throughout the world in recent years. Some of these people tell us that "science has failed," that we should declare "a moratorium on science." As if we now understood all things; as if real understanding is harmful; as if we should seal the book of scientific knowledge of to-day against the generation of to-morrow. People who talk thus, who advise thus can not understand either the spirit or the method of science. We can not afford to declare a moratorium on honesty, on integrity, on objectivity, on experimentation, for that would take us straight back to the jungle. The way of science is away from the jungle, away from its violence and fears. If the way of science at times, such as the present, seems obscure and even dangerous, that is due to too little, not too much understanding, of the nature of man and our universe, and to the further fact that we do not or are not permitted to follow the light of science we now possess.

If our age is "The Age of Science," our rulers, our legislators, our businessmen, our educators, our farmers, our factory workers should give evidence of comprehending, using and following the scientific method. In a recent volume the Dean of Canterbury says: "Our social and economic order is neither scientific nor Christian. When I read, as a headline in the *Observer* that Poland's good harvest was a *severe blow to recovery*, I recalled the words of an American professor of agriculture after seeing ten million acres of cotton ploughed under and five million pigs slaughtered: 'If this will bring national prosperity, then I have wasted

my life.' The thing is monstrous, an age when science is frustrated." In the broader field of human relations, what do we see on the horizon? Conspicuous, certainly, are these: greed, force, faith and war. These are certainly more conspicuous than the ways of reason based on scientific understanding. In the last analysis, *war is murder and stealing on the part of somebody*. War is the extension of the practices of the jungle into modern life. The technique of modern warfare is modified by scientific discoveries, but the elements that make for war are certainly not scientific. Hence the persistence of war can not be laid at the door of science. It is due rather to the failure of science and conscience to as yet essentially modify human conduct. For we must assume that sooner or later reason based on understanding will modify human behavior. Even animals with no cerebrum can be conditioned. But, lest we go too far in this optimistic dogmatism, let us also remember that while we have "tamed" the dog, we have not yet "tamed" the tiger.

The scientific method demands that we suspend judgment until we know the facts. It demands honesty, integrity and industry in ascertaining the facts. *The scientific method and dishonesty are incompatible*. But scientists are but human beings, and they frequently make mistakes both in facts and their interpretations. Now, *is our age conspicuous for honesty and integrity?* Is there less lying and deceit locally, nationally, internationally, to-day than yesterday? The answer is all about us. Modern propaganda, and a good deal in modern advertising, have the earmarks of lying as a fine art, rather than the character of honesty, objectivity, truthfulness and accuracy of science. It is, biologically, evident that we will have to live with greed for some time to come. But the more serious question is: *Can human society survive without individual, social and national guile?* If the answer is "No," we probably have here the most fundamental conflict between the scientific method and society.

Science, in spirit and method, knows no political aspects or national boundaries. Individuals of all races and nations have contributed to our present understanding of the nature of man and of the world. There is no Democratic logic, Republican mathematics, Nazi physics, Fascist chemistry or Marxian biology. The spirit and the method of science can not change with capitalism or socialism. This appears to me axiomatic. But fanaticism in society and governments can temporarily retard discovery and further advance in the understanding and control of life and nature. And yet we hear claims from the Germany of to-day of a special Teutonic or Nazi physics, claims from Russia of something called Marxian genetics, whatever that is. These stupidities characterize our age, but they are not the characteristics of science. If the science of modern biology has made out anything with

a high degree of certainty, it is the fact of the essential unity of our present human race, and that such differences as the skin color, hair color, speech, size of body, etc., are not in any way fundamental. And yet notions of racial superiority and inferiority are widespread—as if the differences in skin color, size of lip or length of nose had any significance when it comes to the capacity of the brain or the control of the emotions. An able American anthropologist wrote last month: "There are no measurable physical or social qualities which are in any given group (of people) superior or inferior." There are, of course, great differences in the kind and quantity of education and in the mechanical appliances due to science among the different peoples of the earth.

If even our so-called educated fellow citizens were scientific their conduct would be more influenced by proven facts than by wishful thinking. At the recent Century of Progress Exposition in Chicago, the Adler Planetarium had a record attendance. So had the shops of the astrologers and fortune tellers on and near the exposition ground. If there is anything that has been proved to the hilt in biology and medicine during the last hundred years, it is the effectiveness of vaccination against smallpox. There are no ifs and ands about it. It is one hundred per cent. effective, and practically one hundred per cent. safe. Of course, wherever human hands, human agencies, are involved accidents will happen sometimes. We can't do much, at present, to prevent colds, pneumonia, cancer, diabetes or too high blood pressure, but we can prevent the deaths and the disabilities from smallpox by protective vaccination in early infancy. And in most cases the immunity thus conferred lasts throughout life. Despite all these facts, men and women in this and other civilized countries neglect and oppose vaccination against smallpox. We have large groups of people organized into "anti-vaccination societies." And these are not all ignorant people. Some are college graduates. If these people walked in the way of science, they would accept and be guided by proven facts.

The exact biologic relations of man to other animals are still, in part, a matter of theory. Animal evolution is usually slow. Most of what we see of it to-day took place in the past. We can only dimly observe the past; we can not experiment with it. Animal evolution is probably now going on, but so slowly that we usually fail to discern it. But the essential identity of the structure and function of tissues and organs in man and animals is not a theory. It is a proven fact. The heart, the liver, the stomach, the lungs, the blood, the eyes, the ears and even the brain are made up of the same stuff, and subjected to much the same diseases, wear and tear and aging in man and animals. It is also true that practically 90 per cent. of the under-

standing gained in the last hundred years of preserving health and controlling disease has been secured through experiments on animals. And yet people, even in civilized countries, oppose experiments on animals as futile and cruel, as of no benefit to man. These people are not all ignorant. But they surely are not scientific. They do not accept, they are not guided by proven facts. Their thinking and motivation have not been touched by the spirit and the method of science. Moreover, the majority of people in some of our states, through their legislatures, pass "anti-evolution" laws, as if the course of events of the past could be altered by legislative dicta of to-day. The legislatures of Tennessee, Ohio or Kansas might pass laws against floods, drought, dust storms, grasshoppers and similar catastrophes, but that would be as futile as it is unscientific.

It is still a common practice of man, so-called civilized man, to follow *post-hoc* reasoning; that is, because one event may sometimes follow another, the two events are therefore necessarily causally related. Mankind as a whole, and even leaders in business, industry and government, do not yet thoroughly understand or follow the *principle of control*, the *principle of experiment*. *Post-hoc* reasoning is one of the commonest sins against the scientific method, and we still see it occasionally in those who should have been trained in science; for example, modern physicians. As an example of *post-hoc* reasoning in medicine, I can cite the case of a physician who had practised medicine honestly in a far western state for forty years. A number of years ago, he told me in all seriousness that he had discovered a specific remedy for influenza. I was naturally curious, because influenza is one of the maladies which has so far largely defied modern scientific control. On being asked what his remedy was, he replied, "Good whiskey and plenty of it." The doctor was apparently perfectly sincere about it. When I asked him how many influenza patients he had treated without whiskey and how many of these recovered, he looked at me in surprise and said: "You understand, I have treated every one of my influenza patients with whiskey during the last forty years, and I have had a high percentage of recovery." This physician, though stupid, was too honest and venerable to poke fun at. I was tempted to ask him how many recoveries from influenza he thought he would have had if he had had them read Mary Baker Eddy's "Science and Health" at an angle of 45 degrees, practised Couéism, or had their spines or toes twisted according to the chiropractor's cult. Another example is that of another honest physician in a southern state using a remedy whose virtue, if any, was essentially 20 per cent. alcohol, a so-called female tonic, a Southern counterpart of Lydia Pinkham's well-known vegetable compound. The case was that of a young girl

working twelve hours a day in a factory in a Southern city at low pay. She lived in a garret room, with poor food and poor sanitation. She had a high degree of anemia. The doctor wrote: "I took this girl out of the factory, sent her to the country for three months with relatives and gave her this female tonic. After three months she had nearly recovered from her anemia, thanks to this tonic." It is not surprising that even physicians fall into this error of reasoning, because in the not distant past medical education was only partly scientific and physicians are only human.

To what extent or in what sense is science in conflict with society? I think there is much confusion, misunderstanding and unwarranted generalizations on this point. Not so many years ago the American Association for the Advancement of Science declared, by resolution: "Science is wholly independent of national boundaries, and races, and creeds and can flourish only where there is peace and intellectual freedom." This position is clearly in conflict with the cyclical psychosis exhibited by *homo sapiens*, in mass, throughout the ages. But whether there is a conflict of science with the primary interest and ultimate well-being of society is at least an open question. Only last year an outstanding physicist declared: "Science makes man human." I presume our colleague meant that science tends, or should tend, to make man more human. The possible conflict between science and society in this statement obviously depends on our conception of what are the desirable human qualities, or behaviors, to-day and to-morrow. If these are deceit, violence and war, there is conflict between science and society, for deceit, violence and war are the very antithesis of the scientific method. Two years ago a colleague uttered the following dictum: "Here on this continent where science has achieved its greatest application, science is in conflict with society. Science and technology have gone so far that the present social structure is facing its debacle. Nowhere else in the world to-day is science in such militant conflict with the social structure under which science survives." The same author also speaks of the "prostitution of science for war." We have here, clearly, a confusion of science and the scientific method with the uses, largely by a non-scientific society, of the understandings and the gadgets developed by the methods and the applications of science, for satisfaction of the ancient human drives of greed, hate and vanity. The modern use of scientific gadgets and forces for violence and war is not essentially different from the ancient use of the hand, the teeth, the rock, the stick and the club in similar drives by our primitive ancestors.

Recently the President of the United States addressed a letter to the president of the Massachusetts Institute of Technology, calling upon the engineering profession to "cooperate in designing accommodating

mechanisms to absorb the shocks of the impact of science on society." It seems to me that here, again, we have a confusion of the scientific method and science with technology, and an identification of science in general with the scientific achievements in chemistry and physics. Is it not the technology developed through the latter achievements with which our President is concerned? Evidently the President, though he said so, did not really mean science in general or the scientific method, for if our fellow citizens really are shocked by new data, new generalizations, new uses and controls of matter and energy, new understandings of man and the universe brought forth by science, what kind of shock absorber would he suggest against such new knowledge, and would he not agree that those who are shocked by new understandings should be so shocked? For instance, what kind of shock absorber for society may we look for in the matter of the biologic and medical sciences and the services of modern medicine, especially in prevention and control of infections and the application of modern knowledge of nutrition? To be sure, society once appeared to be shocked by the theory of the evolution of life, and the growing evidences of the unity of all life. These facts do disturb some people, but in my judgment that disturbance is wholesome for society. However, the science of modern biology and medicine certainly helps to preserve and to prolong the life of the ablest as well as the least fit members of society, least fit physically and mentally. Biology and medicine have also greatly increased the average life span, so that to-day society has a greater percentage of members past fifty, sixty and seventy years. To be sure, modern warfare tends effectively to counteract this "impact" of science on society. And it is not yet clear that the lengthening of the life span, particularly the effective life span, is an undesirable "impact." In brief, the alleged conflict between science and society is based largely on misunderstanding and on unwarranted generalizations.

The services of science to society are, primarily, increased knowledge and understanding. That such increased knowledge, understanding and control of the forces of nature are used, not by scientists, but by society, with increasing effectiveness in the continuous and recurrent drives to satisfy greed, lust, hate and vanity, will, in my judgment, ultimately prove to be due, not to the inherent nature of the scientific method or of knowledge *per se*, but to the failure of man, so far, to be effectively conditioned by science and the scientific method.

It is sometimes asserted that science is amoral if not immoral. The latter may be true, if it is immoral to challenge and destroy taboos and traditions based on ignorance and misunderstanding. But to call the impartial, industrious and earnest search for new

knowledge amoral or immoral conflicts with my conception of immorality. As I understand it, there is no conflict between the scientific method and our sense of justice, though I admit that the latter stems from a much broader base than science. Individual scientists may at times, in their ivory towers, express distrust of society or the common man, as disclosed by the following recent statement from an eminent surgeon: "Whether the public interest (in medical research) is something deeper than curiosity, and whether it can be relied on as a potent factor for the common good have not been demonstrated. Indeed, a study of the historical background of surgery invokes in the mind of the medical scientist a distrust of the public." The doctor cites among other examples the Edict of Tours (1165) declaring surgery not respectable. But that edict was not the work of the common man. It was a product of the leaders of the church.

On the other hand, the defeatists among us, noting the conspicuous though superficial rôle of science in modern thought and modern life, occasionally see in science and the scientific method the very root of some of our modern ills. Thus the leaders of a little college on our Atlantic seaboard have boldly undertaken to rectify a conspicuous educational failure of Harvard University by providing "conditions for liberalizing and humanizing science." And this the college hopes to achieve by the "strategy of taking specialists in the sciences and re-educating them in the liberal arts." We are not told what to do for or do with the people who were educated in the liberal arts before they became specialists in science. Maybe these unfortunates are acephalic satraps of Satan or just dead and do not know it. A pessimistic colleague in the social sciences recently referred to our times as one of "intellectual chaos and moral confusion which has undermined the confidence of men. It has become so common to justify the bad and belittle the good, that the words good and bad, honor and dishonor, truth and falsehood have lost most of their meaning for persons who influence public opinion." Even if this pean of pessimism is entirely true, what evidence have we that it was better instead of worse yesterday, a hundred, a thousand, a hundred thousand years ago, when science and the scientific method were unknown? Few if any real scientists will take exception to the humanist who insists that "under the shelter of the word culture there must be room for a more dynamic ingredient added by the person who can produce fine things." I think among the "persons who can produce fine things" are the men of science, and among "the fine things" are new facts about men in health and in disease, new facts about the universe, new facts about the nature of life and matter, new understanding and new powers of control of the forces of nature.

Many world events in recent years have made some

assert that worthwhile human society can not persist or prevail without the perennial supremacy of deceit and greed, violence and war. Others question whether these very antitheses of the scientific method can persist side by side with science and the necessary human qualities that go with the method of science. Deceit, violence and war have certainly been with us before the dawn of history as a part of the "struggle for existence," while science and the scientific method are of a much more recent vintage. It is also true that the "struggle for existence" in smaller groups such as the family, the tribe, and the nation ultimately curbed, at least in part, both deceit and greed, violence and war. Can such curbing be achieved on a larger scale or is it desirable that such curbing of man's past drives be achieved in the interest of the future welfare and progress of man? So far as I can see there is only one answer to this question, and that answer is given both by history and by the primary interest of society. To refer again to the resolution of the American Association for the Advancement of Science: "Science can flourish only where there is peace and intellectual freedom." Are intellectual freedom and peace the desiderata for man? If this is so, there is no fundamental conflict between science and society, as I view society of the future. But some of us are inclined to take the more virile position of the immortal Pasteur who said: "Science and peace will triumph over ignorance and war." But to-day the "blackouts" imposed by our modern barbarism seem particularly monstrous, partly because of the current bright light of scientific understanding. The endemic and cyclical psychosis of our race is nothing new. There were shackles, even more deadly, on the human mind in other ages. There were burning libraries and rivers of human blood in other days and climes. But through the past and present immense and ugly wilderness of man's inhumanity to man there runs a trail, at times scarcely discernible, but still a trail, blazed by the search for understanding, occasional kindness and the groping for justice.

The evident failure of modern science to measurably influence human drives and conduct, individually, nationally, internationally, are probably to be sought in three factors: (1) the character of our prevailing education. Our prevailing education, starting in the home and in the church, in the grade school and the high school, and extending into the college, is largely *education by dictation*. It is indoctrination rather than education by understanding the why and wherefore through experimentation and controlled observation. This applies to countries other than our own. There are those in our own country who insist all along the line on education by more and more dictation and indoctrination. Merely the memory of and the ability to repeat a heterogeneous number of facts, or even

coordinated facts discovered and interpreted by science, is not education in the method of science. We can teach a parrot to talk Latin and repeat a syllogism, but that Latin-speaking bird is still a parrot. In the bulletin of the Association of American Colleges for December, 1935, there is an article entitled, "The Alumni Go to College." In this article are brief accounts of faculty offerings to the alumni of their respective schools. Science is not even a "second best," an "also ran." But Princeton offered its alumni "Modern Problems in Sea Power." Wooster University offered "Suggestions for Travel in England." Mount Holyoke reported on "We Americans of To-day" and "The Church in the Nazi State." At Rollins they took "An Excursion into the Field of Biology," which might mean anything, and in 1933 Lawrence College had something on "The Subterranean World," which may have been either geology or politics. The University of Akron listed as important food for alumni thought: "The New Deal and Foreign Trade." Barnard College evidently considered it most important for its alumnae to learn "How to See a Play," and also to learn something about "The Modern Dance Movements," and in 1935 Lawrence College presented its alumni "Gothic Architecture" and "The Artistic Prospect of the Cinema in America." Evidently these topics interest and entertain our alumni. They remind us of a recent paper on education, entitled, "Learning and Lollipops." But do we have to follow Hollywood? Are we sure that our alumni can not digest stronger meat? If they can not, there is little of worthwhile significance in our A.B. and B.S. degrees. It is interesting to travel in England; but to us it is more important to live the full life in America. The latter demands something more than "Modern Dance Movements" and the "Artistic Prospect of the Cinema." It demands the latest news on heredity, on the electron and the proton, on bacteria and health, on soil conservation, chemistry and cancer; on birth control and pest control; on better foods, better homes, better children; and on a thousand other problems of life on which science has provided understanding and working out our control.

(2) Considerable responsibility for the failure of science to essentially modify human conduct must be laid to the scientists themselves. Many of us are scientists only during our working hours, and fall into the common errors of the average man when we step outside our own specific field. Many of us have considerable fog in our brains and clay in our feet, and this is discerned by leaders in other human endeavors and by the man in the street. Scientists frequently become dogmatic both inside and outside of their own fields. A few years ago a British biologist of some standing published a little book ("Heredity and the Ascent of Man") in which he tells us that: "Perhaps

the most serious obstacle in the way of any permanent intellectual improvement in the human race is the democratic nature of the governments which make the laws and rule the affairs of the more civilized states. . . . Recent events in Italy and Germany, where democracy has been replaced by dictatorship show the practical possibilities of state action for race improvements." As if anything could possibly be proved in the way of elevating German and Italian character and intellect in the short period that these dictators have held sway. For the progress of science the very antithesis of dictation and regimentation seems the most favorable environment. But it appears that even the most thorough conditioning in the natural sciences does not always carry over into the problems of social, economic and political relations. A few years ago an American zoologist wrote a book with the title "Out of the Night," a queer book from the pen of a man of science, in which he tells us that: "In the capitalistic state the search for truth will eventually languish of its own internal debility." The title of this book is "Out of the Night." It should have been "Into the Fog." For is it not fact that the individual search for truth is an internal drive, to be sure, influenced by the political, social and economic environments, but, at least in part, independent of them? The dawn of science antedates capitalism. Science has been fostered, at least by individual capitalists, and the record of dictators in the matter of fostering the scientific way of life is, to say the least, as varied and uncertain as that of capitalists. There is an embryonic dictator beneath the skull cap of every man. And the fury against individual freedom, science and honest inquiry is not confined to any race, creed, clime, economic or political order.

(3) The third factor is the tremendous resistance of man to new ways of thinking and new ways of life. During the past million years that man has evolved under the influence of the non-scientific or raw environment, he has developed emotions and habits and drives that are not easily, speedily or permanently modified by the environments and techniques developed by man himself through science. There is no use crying over this situation. It is one of the recognized scientific facts, and we must accordingly work toward the goal with longer vision and greater tolerance and patience. Science as an educational and social force is but of yesterday. Man has been exposed for ages to the fundamental ethics of the great religions, using the elements of fear, punishment and perpetual reward as motives, something that science can not do. And yet the effects of this exposure seem neither significant nor lasting.

From all the evidence now available it seems clear that in the past greed, guile and violence had survival value for primitive man. Assuming that these drives

can be curbed on a national or international scale by new mores based on understanding, reason and emerging justice, will the latter have equal survival value in and for the kind of society we hope to build? My answer is yes, with this proviso: I think we must apply new and different measures to reduce the number of the least fit. We have enough information to make a beginning in that direction now, but prevalent mores prevent it. Unless reason based on understanding effectively guides social evolution of to-morrow in the direction of elimination or reduction in number of the least fit, those who can not or will not strive for the individual and the common good, I see no escape from the degeneration that invariably follows biologic parasitism, except the ancient law of tooth and claw.

Now, I shall try to say in one minute what I probably failed to make clear in fifty. As I see it, ours is not an age of science. Men are still driven by greed and confused by guile, rather than guided by reason based on our expanding knowledge. Science has greatly enlarged man's understanding, conquered many of his diseases, lengthened his life, multiplied his joys, decreased his fears, and added much to his physical comforts and powers. But man may and does use these and other achievements for a greater social injury, instead of for a further social advance. Science is specifically human, in that it stems from the innate curiosity of all men, and the conspicuously plastic brains of the ablest, if not the noblest, of our fellows. If this be so, it follows that the scientific method and its products can not be, in any fundamental and permanent sense, in conflict with human nature, though our present human society, a product of the past, dominated by greed, force and fear, may be and is in conflict with the scientific method. Whether science and the scientific method, whether understanding, honesty, reason and justice can contrive survival values equal, if not superior to the blind forces of nature which shaped man's past, is as yet in the laps of the gods. Still, we can not deny the possibility, and we will nurse the hope that the hairy ape who somehow lost his tail, grew a brain worth having, built speech and song out of a hiss and a roar, and stepped out of the cave to explore and master the universe, may some day conquer his own irrational and myopic behavior towards his kin.

I think we can say, even in the face of current pessimism, that during the ups and downs of a million years man has gradually acquired more understanding, more freedom from fear, more dignity, greater kindness and a clearer conception of justice. Even though for the moment, "the bird of sorrow" is not only flying over our heads, but is actually nesting in our hair—to borrow a Chinese proverb—that bird will not nest in our hair forever, even though a blackout on the light of science is decreed in every land. For, slowly but

surely, the method of science will help to make life more intelligent, toil more cheerful, fear and hatred, pain and tears less prevalent in our lives. If in any place or time the blind fury of hatred of our brethren

and the insane violence of war render the pursuit of science impossible, and the scientific method submerged and forgotten, it will be rediscovered, in better days, by better men.

CONTRIBUTIONS TO SCIENCE BY THE RESEARCH LABORATORY OF THE GENERAL ELECTRIC COMPANY¹

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ON this program in celebration of the fortieth anniversary of the Research Laboratory of the General Electric Company, I am privileged to represent the thousands of scientists in every field of research whose work has been significantly aided by the generous cooperation of the members of the staff of this laboratory, and who have been stimulated by the fundamental scientific discoveries that have come out of it in continuous succession. A typical example, of hundreds of similar situations, was my first contact with this laboratory just thirty years ago.

As a graduate student in Princeton University I was working under O. W. Richardson, the distinguished British physicist who first understood the true nature of thermionic emission—the emission of electrons from hot metals which is the basic performance of filaments in radio tubes and x-ray tubes. Richardson's experiments had led him to conclude that this emission was really an evaporation of electrons out of the hot metal, but another school of thought held that the phenomenon was due to chemical action on the filament by residual gases in the enclosing evacuated tube.

At that time Richardson visited the laboratory in Schenectady. He learned from Langmuir that what scientists had theretofore called "high vacua" were really very crude vacua indeed, and that by prolonged heating of the glass tube nearly to its melting point and by even more vigorous heating of the metallic electrodes contained within it, the amount of residual gas could be reduced a thousand-fold below the amounts in the best vacua hitherto realized by scientists. This new high vacuum art having been disclosed to Richardson, he was able to return to Princeton and prove by conclusive experiments the fallacy of the chemical theory of thermionic emission.

At the same time Langmuir, who had even then been pioneering in the properties of surfaces, showed that thermionic properties which Richardson had thought characteristic of tungsten were really due to

layers of thorium, not over one atom thick, which formed on the tungsten surface by diffusion of this impurity to the surface of the hot tungsten filament and which for many purposes greatly improved its ability to emit electrons.

This incident recalls a whole group of scientific investigations and their practical applications which have been main lines of continuous study in this laboratory. Coolidge's discovery of a way to make ductile tungsten, and hence tungsten filaments, revolutionized the incandescent lamp industry. It, and the high vacuum studies, led to the Coolidge x-ray tube now in practically universal use. These, with Langmuir's work on surfaces and diffusion, led to improved radio tubes and hydrogen arc welding. Langmuir's studies of surfaces have contributed much to our knowledge of chemical reactions and are now opening up new vistas for the physiologist in his study of biological actions at membranes and cell boundaries in living organisms. As by-products of the x-ray, and to a considerable extent through the work of Hull in this laboratory, has come our modern knowledge of the arrangement of atoms in crystals. Using thermionic emission as a tool and making new applications of the kinetic theory of gases, Langmuir and Tonks have made the most notable contributions of the past twenty years to our knowledge of the complex, but highly interesting, important, and often spectacular, phenomena of ionization and electrical conduction through gases. By his scholarly exposition of such diverse subjects as magnetism, quantum theory and atomic structure, and by his able direction of research efforts, Saul Dushman has been a worthy collaborator in this highly individualized but well coordinated group.

If time permitted I should like to mention other scientific achievements of this laboratory, and other able contributors to its program, for they are many. I have only mentioned a few of the high spots by way of suggestion of the scientific work which has gone forward in what the public has come to think of as the "House of Magic"; but whose "magic" is in reality the logical outcome of systematic, orderly hard

¹Fortieth anniversary celebration of the Research Laboratory of the General Electric Company, Schenectady, December 17, 1940.

work following with painstaking detail, step by step, the testing and development of ideas—always aiming first at a full understanding of materials and their behavior and with faith that, once these things are really understood, they can be used more advantageously. But let me close with a more general comment.

More significant than the specific discoveries on the programs of research in this laboratory has been the fundamental philosophy of its operation, and this is the great pioneering achievement of the man who directed and guided it from its beginning, Dr. Willis R. Whitney. He had supreme faith in science and in men. He conceived of a great industrial research laboratory, not as a place where mediocre men would carry on routine tests to help production men with their week-to-week problems or as a place to make inventions whose financial value to the company would show in black ink on the cost accountant's books at the end of the year or as a storehouse of industrial secrets. He thought of it as a center for the advancement of knowledge and art in all things pertaining to electricity and for the stimulation of such knowledge and art everywhere for the benefit of mankind. He realized that, in the long run, his company would benefit more from a general advance in knowledge

and use of electricity than from the selfish accumulation of a lot of trade secrets. He furthermore had great faith in men; having selected men of brilliant ability and high character and loyalty to the enterprise, he gave them every possible encouragement and support, and protected their freedom to explore the unknown. At the same time, Dr. Whitney saw to it that the laboratory was alert, as opportunity arose, to the possibilities for reducing to practical applications the scientific discoveries which ensued. In all this he was ably aided and abetted by that prince of executive engineers, Larry Hawkins.

These basic policies are now being continued by Dr. Whitney's successor, Dr. Coolidge. They have stood the test of time and have been an inspiration to scientific men everywhere. I can express no greater hope, on this happy occasion, than that they will continue to receive the farsighted support of the officers of this great company.

Some one has remarked that, in every era of history, the stage of civilization has been limited by the tools at man's disposal. Tools and men with ideas—these have been the great contributions to our era from the Research Laboratory of the General Electric Company.

THE RESEARCH LABORATORY OF THE GENERAL ELECTRIC COMPANY

By L. A. HAWKINS

EXECUTIVE ENGINEER, RESEARCH LABORATORY, GENERAL ELECTRIC COMPANY

THE fortieth anniversary of the founding of the Research Laboratory of the General Electric Company was celebrated on December 17, 1940.

Research in General Electric had its beginnings long before 1900. It may be said to have started with the scientific investigations by Professor Elihu Thomson in the 70's of the last century, while he was a teacher in a Philadelphia high school, for those investigations and the developments consequent upon them laid the foundations on which the beginnings of General Electric were built. Thomson continued his scientific studies throughout his long and fruitful life. He was the first great industrial scientist in America. That fact was fittingly recognized at the Research Laboratory's birthday party by the unveiling of a plaque in his memory.

But it was in 1900 that the present Research Laboratory had its small beginnings.

In December of that year a young professor of chemistry from M. I. T., Dr. Willis R. Whitney, came to Schenectady to give half his time to research in the electrical field. The half-time arrangement had been made because Whitney doubted if enough worth-while

problems could be found to occupy him fully. He began his work in a barn then used by Dr. C. P. Steinmetz as a laboratory, sharing the services of Steinmetz's single laboratory assistant. Two or three weeks later the barn burned down, and a small building was made available in the Schenectady Works, into which Whitney and his assistant moved. In June, 1901, five M. I. T. graduates were brought to Schenectady, and the growth of the laboratory was begun.

The purpose of the Research Laboratory was made clear in the following extract from the annual report of E. W. Rice, Jr., third vice-president, to President Coffin:

Although our engineers have always been liberally supplied with every facility for the development of new and original designs and improvement of existing standards, it has been deemed wise during the past year to establish a laboratory to be devoted exclusively to research. It is hoped by this means that many profitable fields may be discovered.

It did not take long for Whitney to perceive that there were more than enough worth-while problems in the company's field to occupy the full time of himself

and a growing staff of assistants for a life-time and more, so he severed his connection with M. I. T. and thereafter devoted himself entirely to building up the laboratory which stands to-day as a monument to his life's work.

In 1905, Whitney induced a former colleague of his at M. I. T., Dr. William D. Coolidge, to join him in Schenectady. Coolidge became almost at once Whitney's right-hand man, and in 1908 was made assistant director of the laboratory. When, in 1932, Whitney retired from the directorship to devote himself to his first and dearest love, experiment, Coolidge succeeded him as director, and in 1940 was made vice-president of General Electric Company, as Whitney had been in 1928.

1909 is another milestone in the laboratory's progress. In that year a young instructor at Stevens Institute of Technology, Dr. Irving Langmuir, went to Schenectady to spend his summer vacation in the laboratory. He found so much to interest him there that he stayed on to become later its assistant, and still later its associate director.

The year 1912 brought to the laboratory Dr. Saul Dushman, whose work on high vacuum and on fundamental physical theory is well known, and 1913 brought Dr. Albert W. Hull, the creator of more new types of electron tubes than any other man. Both later became assistant directors of the laboratory.

In its second decade the laboratory was growing rapidly. Its researches were bearing valuable fruit, especially in the lighting field. Whitney's metalized carbon filament, Coolidge's drawn tungsten filament and Langmuir's gas-filled lamp had, step by step, quadrupled the efficiency of the incandescent lamp of 1900. The magnetite arc, another product of the laboratory, alone survived for a time the competition of the new illuminant in street lighting. Improvements in silicon steel were reducing the core loss in distribution transformers. The graphitized brush was eliminating costly delays due to brush failures in heavy duty electrical transportation. Tungsten contacts for automobile ignition were replacing expensive platinum and simultaneously reducing ignition troubles almost to the vanishing point. The first sheathed-wire (later, "Calrod") heating units for electric ranges had been produced. New alloys and new insulations were improving the company's products.

Soon came the Coolidge x-ray tube, transforming x-ray technique from a tricky art to an exact science and greatly extending the scope and utility of x-rays; the radio power tube, the most essential element in radio broadcasting; the Tungar rectifier for battery charging; the screened grid tube for efficient radio frequency amplification, together with the "tron" family—kenotron, pliotron, magnetron, dynatron and thyatron, with their diverse and valuable uses; the

atomic hydrogen welding torch, extending the field of electric welding; the copper brazing process in hydrogen, useful in a variety of fabrications; the calorizing process for protecting metals against oxidation at high temperature; the electro-dynamic loud speaker, giving high-fidelity reproduction; glyptal resins in their various forms; the oil-immersed x-ray unit, which made dental radiography safe and much more convenient; carboloy for heavy duty machine tools, the cascade principle of tube design which made possible x-ray tubes for operation on a million volts or more; special alloys, such as fernico for glass metal seals and alnico for permanent magnets; the inductotherm for producing artificial fever in therapy; novel forms of automatic balancing machines; highly sensitive mercury vapor detectors; new insulations such as flamenol for cables and formex for enameled wire; and, most recently, the hermetically sealed, gas-insulated, million-volt x-ray tube and resonance transformer for high-speed industrial radiography.

The foregoing list could be considerably extended, but it is more than long enough to show the variety and importance of the Research Laboratory's contributions to the products of the company and to the development of the electrical art.

To produce such results, naturally much applied research and development work were required, but the primary function of the Research Laboratory—fundamental research—has never been forgotten. Although developmental work and services to other departments on special problems have always demanded a large share of the laboratory's activities, fundamental researches in the physical, chemical and metallurgical phenomena underlying the company's work have been continuously carried on. It is from such researches, broadening and deepening knowledge, that the radically new things come. Some of the most important of the developments listed above had their origin in such researches. The belief that fundamental research is likely to prove, in the long run, most effective in promoting the interests of the company and of the electrical industry has resulted in the encouragement of such research throughout the laboratory's history. That encouragement, and the freedom permitted in the prosecution and publication of fundamental investigations, have often been strongly influential in attracting good men to the laboratory's staff. They have also resulted in enabling the laboratory to make important contributions to the advancement of science. An address by Dr. Karl T. Compton, delivered at the laboratory's recent birthday party and published in this week's issue of *SCIENCE*, is a gracious acknowledgment of the significance of that aspect of the laboratory's work.

Many medals and other honors have been awarded by scientific societies and other institutions to mem-

bers of the laboratory's staff. Langmuir, its associate director, was the first industrial scientist in America to receive the greatest prize in the field of science—a Nobel award.

The Research Laboratory, with its 305 employees, of whom 130 constitute its technical staff, is only one of sixteen laboratories maintained by the General Electric Company, but the company's policy is to concentrate in it researches of a fundamental nature. The

growth of the other laboratories, particularly the Works Laboratories, of which there is one at each of the larger factories, has facilitated the expansion of fundamental research in the Research Laboratory by relieving it in large measure of much of the developmental and service work it was formerly obliged to do. There is therefore reason to hope that its contributions to science will increase, rather than diminish, in the years to come.

OBITUARY

DAVID HILT TENNENT

QUIET, reserved, modest and intent, D. H. Tennent pursued his consistent life of study and teaching through thirty-six years in the congenial surroundings of Bryn Mawr. Successor there to the position held by such distinguished men as Loeb, Wilson and Morgan, he leaves a profound impression upon the institution which he so long served and upon the many students he taught and inspired. For one year he varied this routine in 1930 by occupying the position of visiting professor at Keio University, and again, at intervals, by going on collecting expeditions to such widely remote places as Australia, Japan and Jamaica. The same interests made him a frequent visitor to the Tortugas Marine Station, of which he was the executive officer from 1937 to 1940, and to Cold Spring Harbor, Beaufort, Pacific Grove, Naples and Woods Hole. Always these trips were made to secure Echinoderm material for his cytological and embryological studies.

Beloved by his friends, honored and respected by his college, he inspired universal esteem among biologists for his extensive, consistent and suggestive work upon fundamental problems of the cell, which continued up to the day of his death. These deal largely with the history of specific chromosomes in cross-fertilized eggs and with the effects of foreign agents upon developing ova, including the photodynamic effects of dyes. Through the years he continued these studies while busy all the time with large teaching and administrative duties. In recognition of his successful combined activities he was honored in 1938 by appointment to the position of research professor, the first instance of this at Bryn Mawr.

Honors came to him also from organizations of scientists, such as election to the National Academy of Sciences, the American Philosophical Society and to the presidency of the American Naturalists and the American Society of Zoologists. He was also a member of Phi Beta Kappa and Sigma Xi. For many years he served on the Board of Trustees of the Marine Biological Laboratory at Woods Hole, where in 1920 to 1922, he had charge of the course in embryology.

In all the fields where he labored he will be greatly missed, both for his sound, constructive work and for the inspiration and pleasure of his companionship.

Dr. Tennent was born in Janesville, Wisconsin, on May 28, 1873, and died at Bryn Mawr on January 15, 1941. He married Esther Margaret Maddux on May 8, 1909. In 1900 he received his B.S. degree from Olivet College and in 1904 his Ph.D. degree from Johns Hopkins. For the year 1903 he was acting professor of biology and physics at Randolph-Macon College. Finally, in 1904 he became attached to Bryn Mawr, where he reached the rank of professor in 1912.

C. E. McCLUNG

RECENT DEATHS

DR. CH. WARDELL STILES, formerly medical zoologist of the Bureau of Animal Industry of the U. S. Department of Agriculture and later of the U. S. Public Health Service, died on January 24. He was seventy-three years old.

DR. LOUIS JOHN GILLESPIE, professor of physico-chemical research at the Massachusetts Institute of Technology, died on January 24. He was fifty-four years old.

DR. D. W. MOREHOUSE, from 1900 to 1922 professor of physics and astronomy at Drake University and since that date president of the university, died on January 21 in his sixty-fifth year.

LEWIS BUCKLEY STILLWELL, consulting electrical engineer of Princeton, N. J., died on January 19 in his seventy-eighth year.

WALTER LORING WEBB, consulting engineer of Philadelphia, died on January 24 at the age of seventy-seven years.

DR. FRANK WEISS TRAPHAGEN, consulting chemist and metallurgist, died on January 21. He was seventy-nine years old.

CHARLES WILLIAM LENG, director of the Public Museum of Staten Island, N. Y., died on January 25. He was eighty-one years old.

SCIENTIFIC EVENTS

THE HIGHLAND PARK ZOOLOGICAL GARDEN AT PITTSBURGH

THE city of Pittsburgh and the WPA have, according to *Museum News*, during the past five years invested together about \$500,000 in modernizing the Highland Park Zoological Garden. The exhibits have been doubled; and about 75 per cent. of the garden's 40 acres of land have been put into active use. Attendance has been greatly increased, Sunday crowds reaching above 30,000.

New bear dens of the barless type have been built, four of them cut into the natural cliff of the park. Native stone was used for floors and concrete for walls. Inside cages between the dens house the bears at night. Steel doors in these cages are arranged so that the animals can be transferred from one cage to another. Pools and stone piles have been arranged to lend an atmosphere of native habitat. Trees and shrubs have been planted in new top soil above and around the dens. The dens are 360 feet long and 60 feet wide; the moat, 13 feet wide and 15 feet deep. Other construction includes adaptation of the snake pit for display of badgers; an island of stone and hard shale inside a six-foot moat for raccoons; an island of sand and loam for prairie dogs; fenced, drained and graded paddocks for wild boar, elk, deer, water buffalo and antelope, with stone shelters and with mud wallows for the elk and buffalo; concrete pools with running water for water-fowl, and an isolation house for sick animals. Sewer and water lines have been constructed to serve these additional facilities.

Construction is under way on a flying cage 56 feet wide, 128 feet long and 60 feet high for birds; a smaller cage for birds of prey; five acres of paddocks in wooded land along the banks of ravines, and a monkey island 55 by 72 feet, with a 13-foot moat, for more than 100 monkeys. Also the main entrance of the garden has been improved and the North and South entrances are being reconstructed; turnstiles, guard houses and retaining walls are being built; walks and steps laid down, and flower gardens planted.

WORK OF THE COMMONWEALTH FUND

APPROPRIATIONS of approximately \$2,000,000 for philanthropic purposes are listed by the Commonwealth Fund in its report for the year ending September 30, 1940. A third of this amount was devoted to medical research and medical education, and nearly half was earmarked for other health services, including chiefly aid to rural health departments and rural hospitals.

Outlining the war-time policy of the fund, Barry C. Smith, general director, writes: "In such a time it is more necessary than ever to steer a middle course be-

tween underplanned and overplanned giving. Without any avoidable sacrifice of social momentum or long-term values, a foundation must do its share toward meeting the needs of the moment. To keep some sort of balance between these two ways of doing something for the welfare of mankind—the slow up-building of medicine and other social institutions, the quick relief of human suffering—is a major task of private philanthropy in war-time."

In accordance with this policy, gifts amounting to \$135,000 were made to meet special war needs through the American Red Cross, the Allied-Relief Fund (now the British War Relief Society), the Finnish Relief Fund, the Harvard Medical School Epidemiological Commission to England and the assistance of English refugees.

Because of the war, the number of Britons studying in this country as Commonwealth Fund fellows has been cut from a normal quota of 65 to 16. Twelve of these are finishing a second year of work, having been appointed in 1939, and are subject to recall by the British, Australian or New Zealand Government. Four new appointees, all ineligible for military service on medical grounds, came to the United States at the beginning of the present college year.

The Child Guidance Council supported by the fund to promote mental health work for children in England has been even more active than in peace-time, British workers reporting that child guidance methods have proved their usefulness among children evacuated from London and other cities. The council has shared in a special appropriation made by the British Government for mental health work during the war.

Appropriations made in this and former years meet all or a part of the current cost of 36 medical research projects at sixteen different institutions. These are the Child Research Council of Denver; the Columbia-Presbyterian Medical Center; the Johns Hopkins University School of Hygiene and Public Health; the Johns Hopkins University School of Medicine; the Memorial Hospital, New York; the Harvard Medical School; the House of the Good Samaritan, Boston; the Irvington House, Irvington, N. Y.; the Michigan Department of Health; the New York Hospital; the New York University College of Medicine; the University of Minnesota; the University of Pennsylvania School of Medicine; the State Serum Institute, Copenhagen; Washington University; the School of Medicine of Western Reserve University and the School of Medicine of Yale University.

A five-year experiment in the control of tuberculosis in Berkshire County, Massachusetts, was completed in 1940. The fund threw its weight behind a general forward movement in local public health service and

the construction of small community hospitals in various states and continued to render services of various kinds to ten older institutions built since 1927. As a contribution to medical education, the fund gave fellowships for advanced study to seventeen teachers in medical schools or to junior staff physicians in teaching hospitals selected for appointment to medical faculties.

THE INDUSTRIAL RESEARCH INSTITUTE AT THE UNIVERSITY OF OKLAHOMA

THE Board of Regents of the University of Oklahoma has approved the incorporation of an industrial research institute. Dr. Homer L. Dodge, dean of the Graduate School, who with President W. B. Bizzell, formulated the plans, recently visited and made a study of several research foundations. The institute will differ from others in that it will include not only the natural sciences and engineering, but also social sciences and commerce.

It plans to make available to industry the investigators and research facilities of the university. Smaller industrial concerns, unable to afford research laboratories and technicians, will be aided.

The institute will be a non-profit corporation and will be conducted without cost to the state. Arrangements for securing funds will be entered into with industrial companies and private individuals. The Board of Regents, therefore, acting through administrative officials of the university, will establish an agency to arrange with industrial concerns for fellowships and research projects and the use of equipment. Three fellowships, financed by individual corporations, are now in existence at the university, and more are expected to be added as the program expands. Patents taken out will be held by the institute, and all royalties received will be used for research.

Since plans have been in process of formation for several years, the institute will go into operation as soon as it is incorporated.

THE SCHOOL OF CHEMICAL ENGINEERING OF CORNELL UNIVERSITY

CORNELL UNIVERSITY has received a gift of a new building for the School of Chemical Engineering, to be erected at a cost of \$700,000. The donor is Franklin W. Olin, of Alton, Ill., a civil engineer graduate in 1886 and trustee of the university, who for many years has been president of the Western Cartridge Company and affiliated concerns. Mr. Olin presented the building as a memorial to his son, Franklin D. Olin, Jr., who received his M.E. degree from Cornell in 1912 and died in 1921. Construction will begin immediately, on a schedule calling for completion in October of this year. The plan contemplates similar buildings for the other three schools of civil, mechanical and electrical engineering, with a materials and metal-

lurgy laboratory equipped to serve the entire college. These buildings will form a new quadrangle on the southern portion of the main university campus.

According to Dean S. C. Hollister,

Olin Hall of Chemical Engineering will have unsurpassed facilities for training in this field. With more than 100,000 feet of floor space, the building will provide numerous laboratories of varying sizes, adapted both to undergraduate instruction and to graduate research. Occupying most of one wing will be an extensive three-story laboratory, enabling students to build and operate large-scale model plants, embracing all the equipment necessary for following through an entire chemical manufacturing process.

These facilities will give our students the means of studying chemical processes not only on a test-tube scale, but also on a basis so closely approximating commercial manufacture that they can readily determine economic as well as engineering factors in designing and operating full-scale plants.

Olin Hall will be an L-shaped structure with three stories above a basement. Both portions of the building will be 60 feet in depth. It will be of fireproof construction throughout, faced in part with native stone to harmonize with Myron Taylor and Willard Straight Halls, which are adjacent. Architects for the new building are Shreeve, Lamb and Harmon of New York City.

An unusual feature of the building is that the majority of the lecture rooms, class rooms and offices will be placed on the ground floor to avoid congestion on stairways. Three lecture rooms, accommodating respectively 300, 110 and 70 students, will be on this floor. There will be a single lecture room, seating 200, on the second floor. Throughout the building there will be numerous small laboratories for specialized instruction and research.

The new building is designed to accommodate approximately 450 undergraduates and a large number of graduate students. The School of Chemical Engineering, under a selective system of limited enrolment, now has 277 students, an increase of 119 in this field since the school was established in 1938.

MEETING OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION

PROGRESS of scientific investigations carried out during the past year at the Smithsonian Institution was reported in January by Charles G. Abbot, secretary of the Board of Regents.

The Astrophysical Observatory has nearly completed the revision of results of measurements of the solar constant—a factor from which can be computed the amount of energy from the sun falling on the earth—for the past eighteen years.

By eliminating a season effect in the cycles of solar variation Dr. Abbot himself has found a closer corre-

spondence with variations in weather on earth, and is carrying out a series of five-year predictions of temperature and rainfall.

In the Division of Radiation and Organisms, which studies the complex interrelations between living things and solar energy, a standardized technique has been worked out for the extraction of growth substances from oat seedlings and evidence obtained of the existence of precursors to these substances and also of possible growth inhibitors.

Other studies have dealt with the lethal and stimulating effects of various wave-lengths of ultraviolet light on one-celled plants, the algae, which afford some measure of their effect on life in general.

There were 212,474 additions to the collections, including a cast of a Neanderthal child skull from Uzbekistan, Siberia; many Eskimo and other artifacts from Siberia and northern Alaska; several varieties of seals from the Antarctic; collections of birds from Vera Cruz and Indo-China; several thousand reptiles and amphibians from Mexico, and 14,000 fishes from the Phoenix and Samoan Islands.

Among the geological collections were a 347-gram flawless aquamarine crystal, a 128-carat emerald crystal from Brazil, 495 Mexican minerals and a large number of Paleozoic fossils obtained in the Rocky Mountains.

It is expected that the formal opening of the National Gallery of Arts will take place sometime in March. It is estimated that the total cost of the building and landscaping, now nearing completion, will exceed \$15,000,000. There have been 59 noteworthy additions to the Freer Gallery, a Smithsonian unit, during the year. These have included East Indian and Arabic manuscripts, Chinese, Indian and Persian paintings and Oriental metal work and sculpture.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

THE Royal Astronomical Society of Canada has elected Dr. Frank S. Hogg, assistant professor of astronomy in the University of Toronto and a member of the staff of the David Dunlap Observatory, as president for 1941. He succeeds Dr. J. A. Pearce, acting head astronomer of the Dominion Astrophysical Observatory, Victoria, B. C., who has been president for two years.

Dr. A. Vibert Douglas, dean of women, Queen's University, Kingston, Ont., and Dr. D. S. Ainslie, associate professor of physics, University of Toronto, were elected vice-presidents.

Other officers are: E. J. A. Kennedy, *general secretary*; J. H. Horning, *general treasurer*; R. H. Combs, *recorder*; Dr. P. M. Millman, *librarian*, and R. S. Duncan, *curator*, all of Toronto.

Members of Council are: S. C. Brown, Toronto; H. Boyd Brydon, Victoria; Dr. J. W. Campbell, Edmonton; Rev. W. G. Colgrove, London, Ont.; Dean Henry F. Hall, Montreal; Dr. Ernest A. Hodgson, Dominion Observatory, Ottawa; Dr. A. E. Johns, McMaster University, Hamilton, Ont.; A. R. McCauley, Vancouver; Andrew Thomson, Canadian Meteorological Service, Toronto, and Dr. L. A. H. Warren, Winnipeg.

The address of the retiring president was presented at the annual "at-home" of the society at the University of Toronto on January 21. The subject was "The Advance of Astronomy, 1890 to 1940." The first award of the Chant Medal, established by the society in recognition of the work of Dr. C. A. Chant, now director emeritus of the Dunlap Observatory, was made to Bertram J. Topham, of Toronto, amateur astronomer.

SCIENTIFIC NOTES AND NEWS

THE Bruce Gold Medal of the Astronomical Society of the Pacific, has been awarded to Dr. Joel Stebbins, director of the Washburn Observatory, Madison, Wis. At the annual meeting of the society, held in San Francisco on January 25, Professor C. D. Shane, of the department of astronomy of the University of California at Berkeley, in his address as retiring president, gave an account of Dr. Stebbins's distinguished services to astronomy. At the same meeting Dr. A. S. King, of the Mount Wilson Observatory, was elected president of the society for the year 1941.

THE Oersted Medal of the American Association of Physics Teachers for "notable contributions to the teaching of physics" was awarded at the Philadelphia meeting to Dr. Robert A. Millikan, of the California Institute of Technology. Dr. Millikan, who was un-

able to be present, sent a message to the association entitled "Opportunities for Teachers of Physics."

IN recognition of contributions to aeronautical meteorology, which includes the development of an artificial means of dispelling fog, Henry G. Houghton, Jr., assistant professor of meteorology at the Massachusetts Institute of Technology, has been awarded the Robert M. Losey prize. The presentation was made on January 28 at the annual honors night dinner of the Institute of the Aeronautical Sciences by Commander F. W. Reichelderfer, chief of the U. S. Weather Bureau. Members of the committee of award were Commander Reichelderfer; Dr. Robert A. Millikan, chairman of the executive council of the California Institute of Technology; Dr. Karl T. Compton, president of the Massachusetts Institute of Technol-

ogy; Major James H. Doolittle, president of the Institute of the Aeronautical Sciences, and Major Lester D. Gardner, president of the Aeronautical Archives of the institute.

THE RITTENHOUSE Astronomical Society of Philadelphia has announced the award of the Annie J. Cannon Prize to Mrs. Julie Vintner Hansen, of the Royal Observatory of Copenhagen.

DR. ARCHIBALD MACLEISH, librarian of Congress, has been appointed honorary chancellor of Union College for 1941. The honorary chancellor spends brief periods in residence on the campus, holding informal discussions with faculty and students, and is the principal speaker at the graduation exercises. Dr. MacLeish will deliver the one hundred and forty-sixth annual Union College commencement address on Monday, June 9.

THE MATHEMATICAL Association of America held meetings at Louisiana State University on January 1 and 2, in conjunction with the meetings of the American Mathematical Society and the National Council of Teachers of Mathematics. Papers were given in a joint session with the National Council by Dr. Virginia Modesitt, Professor H. M. Cox and Professor D. R. Curtiss. At a session on Thursday papers were presented by Professors A. W. Tucker, G. A. Hedlund and Deane Montgomery. Professor R. W. Brink, of the University of Minnesota, was elected president for 1941 and 1942; Professor R. E. Langer, of the University of Wisconsin, was elected first vice-president, and Professor B. H. Brown, of Dartmouth College, second vice-president. Regional governors were chosen at the time of the meeting to represent seven of the fourteen regions into which the United States and Canada are divided.

AT its business meeting in Philadelphia on December 27, the American Physical Society elected as its president for 1941, Dr. George B. Pegram, professor of physics and dean of the graduate faculties at Columbia University. Professor Pegram was also re-elected treasurer of the society. Dr. George D. Stewart, professor of physics at the State University of Iowa, was elected vice-president. As secretary of the society, Dr. Karl K. Darrow, of the Bell Telephone Laboratories, New York, was chosen. The office of the secretary will remain at the Pupin Physics Laboratories, Columbia University.

OFFICERS of the American Society of Zoologists were elected at the Philadelphia meeting as follows: *President*, Dr. R. E. Coker, chairman of the Division of Natural Sciences of the Senior College of the University of North Carolina; *Vice-president*, Dr. J. P. Visser, head of the department of biology at Western Reserve University; *Member of the executive*

committee, Dr. Wesley R. Coe, professor of biology at Yale University.

OFFICERS of the Botanical Society of America have been elected as follows: *President*, Dr. John T. Buchholz, head of the department of botany at the University of Illinois; *Vice-president*, Dr. Sam F. Trelease, Torrey professor of botany at Columbia University; *Secretary*, Dr. Paul R. Burkholder, professor of botany at the University of Missouri; and *Treasurer*, Dr. Paul Weatherwax, professor of botany at Indiana University.

PROFESSOR W. B. HERMS, head of the division of entomology and parasitology of the University of California, was elected at the Philadelphia meeting president of the Entomological Society of America.

THE annual meeting of the Council of the Union of American Biological Societies was held on December 30 in connection with the meeting of the American Association for the Advancement of Science at Philadelphia. The following officers were elected for 1941: *President*, Dr. A. J. Carlson, professor of physiology at the University of Chicago; *Secretary*, Dr. Frank A. Brown, Jr., professor of zoology at Northwestern University; *Treasurer* (for three years), Dr. D. H. Wenrich, professor of zoology at the University of Pennsylvania; and *Members of the Executive Committee*, Dr. B. M. Duggar, professor of plant physiology and economic botany at the University of Wisconsin; Lieutenant Colonel A. Parker Hitchens, George S. Pepper professor of public health and preventive medicine at the University of Pennsylvania, and Dr. George W. Hunter, III, professor of biology at Wesleyan University.

DR. FREDERICK C. LEONARD, chairman of the department of astronomy at the University of California at Los Angeles, will serve as visiting professor of astronomy at the summer session of the University of British Columbia at Vancouver, from July 7 to August 22. Dr. Daniel Buchanan, dean of the Faculty of Arts and Science and head of the department of mathematics at the University of British Columbia, will be visiting professor of astronomy and mathematics at the summer session of the University of California at Los Angeles, from June 30 to August 8. A similar exchange was made by them in 1937 and in 1939.

DR. ROGER B. FRIEND, state entomologist of Connecticut and chief of the department of entomology at the Connecticut Experiment Station, has been appointed assistant director of the State Station and will serve as acting director of the State and Storrs Stations during the leave of absence of Director W. L. Slate.

ARVAL L. ERIKSON has been appointed assistant to the director of the station and assistant agricultural economist at the New Hampshire Experiment Station

and assistant professor of agricultural economics at the University of New Hampshire.

ACCORDING to *The British Medical Journal*, Dr. R. A. O'Brien, who joined the staff of the Wellcome Physiological Research Laboratories at Beckenham in 1910 and became director in 1914, retired at the end of 1940. Dr. J. W. Trevan, who became head of the pharmacological section in 1920, has been appointed to succeed him.

Nature reports that M. Henri Bergson, the philosopher, has refused to be exempted from the clauses of the new statute relating to Jews in France. The exemption was offered him for "exceptional services rendered to literature, science and art." He must therefore resign his chair at the Collège de France.

THE address of the retiring president of the Washington Academy of Sciences was given on January 16 by Dr. Eugene C. Crittenden, assistant director of the National Bureau of Standards. It was entitled "Progress in the Measurement of Light."

DR. R. E. GIBSON, physical chemist in the Geophysical Laboratory of the Carnegie Institution, delivered the address of the retiring president of the Philosophical Society of Washington on January 18. He spoke on "The Physical Reflections in a Chemical Mirror."

DR. JAMES B. HERRICK, professor emeritus of medicine at Rush Medical College, Chicago, will deliver the fifth Christian Fenger Lecture of the Institute of Medicine of Chicago and the Chicago Pathological Society at a joint meeting on Monday evening, February 10, at eight o'clock. His subject is "Christian Fenger as I Knew Him, 1885-1902—A Study in Personality."

DR. W. H. TALIAFERRO, dean of the biological sciences at the University of Chicago, spoke at the Iowa State College on January 15 on "The Biological Basis of Immunity in Infection with the Larger Animal Parasites" and "Biological Basis of Immunity in Malaria." The latter lecture was given under the auspices of Sigma Xi.

PROFESSOR MARSTON T. BOGERT, of Columbia University, on January 17 gave a lecture on "Chemistry in Our Federal Preparedness Program" before the American Institute of Chemists.

DR. A. H. REGINALD BULLER, emeritus professor of botany at the University of Manitoba, recently delivered under the auspices of the Graduate School of the U. S. Department of Agriculture an illustrated lecture entitled "Hyphal Fusions and Protoplasmic Streaming in the Fungi." The lecture was a summary of Dr. Buller's research on the subject.

DR. WILLIAM B. CASTLE, professor of medicine at

Harvard Medical School, delivered the Edward Gamaliel Janeway Lecture at Mount Sinai Hospital, New York, on January 24. His subject was "Hemolytic Anemias."

DR. FRANCIS PEYTON ROUS, of the Rockefeller Institute for Medical Research, will deliver the tenth annual George Chase Christian Lecture at the University of Minnesota Medical School, Minneapolis, on February 5. He will speak on "Present Knowledge of Carcinogenesis."

A LAITY Lecture of the New York Academy of Medicine was given on January 23 by Professor Henry E. Sigerist, director of the Institute of History of Medicine of the Johns Hopkins University. He spoke on "Paracelsus in the Light of Four Hundred Years." In connection with this occasion, there was given at the academy an exhibit consisting of a portrait of Paracelsus made by his contemporary, Hirschvogel; a portrait of Leonico, the teacher of Paracelsus, and portraits of Paracelsus's most illustrious patients, the printer, Froben, and the great scholar, Erasmus. A collection of early publications of works of Paracelsus illustrating his pioneering contributions in the fields of industrial medicine, chemotherapy, surgery, etc., was also exhibited. In addition, there was on view, a collection of modern works dealing with Paracelsus.

THE eight one-week Research Conferences on Chemistry, held each summer at Gibson Island, Maryland, under the auspices of the American Association for the Advancement of Science and under the direction of Dr. Neil E. Gordon, chairman of the department of chemistry at Central College, Mo., have been arranged for the coming summer as follows: June 16, Frontiers in Petroleum Chemistry, chairman, C. R. Wagner; June 23, Catalysis, chairman, E. C. Williams; July 7, Organic High Molecular Weight Compounds, chairman, S. S. Kistler; July 14, Textile Fibers, chairman, Milton Harris; July 21, Vitamins, chairman, C. G. King; July 28, Applications of X-Ray and Electron Diffraction, chairman, Maurice Huggins; August 4, Corrosion, chairman, R. M. Burns; August 11, Photosynthesis, honorary chairman, Charles F. Kettering; chairman, O. L. Inman.

THE forty-third annual meeting of the American Ceramic Society will be held at Baltimore from March 30 to April 5. Headquarters will be at the Lord Baltimore Hotel.

THE Council on Dental Education of the American Dental Association will hold a congress on dental education and licensure on February 15 in Chicago. This congress will bring together for the first time dental teachers and dental examiners in a survey of common problems.

THE three hundred seventy-sixth meeting of the American Mathematical Society will be held at Columbia University on Friday afternoon and Saturday, February 21 and 22. Friday afternoon will be devoted to a symposium on applied mathematics. Brief addresses will be given by Dr. W. A. Shewhart, of the Bell Telephone Laboratories, on methods of mathematical statistics in industrial production control, and by Professor J. J. Stoker, of New York University, on the mathematical problems connected with the bending and buckling of elastic plates. Each address will be followed by a discussion led by mathematicians active in the fields involved. On Saturday there will be sectional sessions both morning and afternoon. At a general session on Saturday afternoon, Professor H. F. Bohnenblust, of Princeton University, will give an address entitled "Partially Ordered Linear Spaces."

APPLICATIONS to the Committee for Research in Problems of Sex, National Research Council, for financial aid during the fiscal year beginning July 1, in support of work on fundamental problems of sex and reproduction, should be received before April 1. They may be addressed to the chairman, Dr. Robert M. Yerkes, Yale School of Medicine, New Haven, Conn. Although hormonal investigations continue to command the interest and support of the committee, preference, in accordance with current policy, will ordinarily be given to proposals for the investigation of neurological, psycho-biological and behavioral problems.

DISCUSSION

A FURTHER COMMENT ON STABILITY IN NOMENCLATURE

WE owe to A. C. Smith¹ a very informative discussion of Wheeler's proposal that new series of beginning dates in botanical nomenclature be started from the publication of certain "uniform monographs executed with strict regard for the rules of botanical nomenclature and the type concept." It is my belief that Smith's observations fully dispose of Wheeler's proposal, showing its glaring defects and inconsistencies. Some additional notes may be desirable, nevertheless, as neither of the parties involved in the discussion seems to have taken into open account what is probably the fundamental fallacy of Wheeler's proposal.

Any form of organized knowledge, taxonomy not excluded, is by its nature progressive, or should at least strive to be progressive. Thus the *names* which a form of organized knowledge uses at any given stage of its evolution and development merely cloak certain

IN connection with its defense work the War Department is in need of technical editors to perform various writing duties, and prepare for publication technical manuscripts and reports. The work will be confined largely to the fields of engineering, chemistry and physics. The salaries are \$2,600 a year for assistant technical editor, and \$3,200 a year for associate technical editor. To fill these positions the U. S. Civil Service Commission has announced an open competitive examination, and will accept applications not later than February 20 and February 24. Also in connection with the National Defense program, an examination will be held to fill the position of chemist-petrographer. The salary is \$3,200 a year. Application should be made not later than March 3. Difficulty is being experienced in filling positions in such branches of technology as explosives, fuels, plastics, rubber, minerals and textiles. These will be filled in several grades with salaries ranging from \$2,000 to \$5,000 a year. For the grade of junior technologist in any specialized branch, applicants will be required to take a written general test. For the other grades, competitors will be rated upon their education and experience. Applications for the position of junior technologist must be filed at the Commission's Washington office not later than February 20. For the other technologist positions, applications will be rated as received until December 31, 1941. Further information and application forms may be obtained from the Secretary of the Board of U. S. Civil Service Examiners.

concepts that are then current. It is manifest that changes in *concepts* can not take place without changes in *names*. Somebody may hope that his *names* for the classification of the family in which he specializes are definite and certain—which may or may not be the case, as many are the controversies that arise over points in which involved issues are left to the common sense of the debaters—but he has not the slightest means of being certain that the generic and the specific names which he uses in the classification of this or that family will last when new concepts of classification must be adopted in view of new approaches to the problems of systematic. It casts a peculiar light upon the assumption of a purely nomenclatural branch of taxonomy that this branch should strive to the utmost to preserve *names* without giving heed to the possibilities of changes of *concepts*.

It may be objected, of course, that the hoped for monographs will merely remain as a basis for nomenclature, it being free to everybody to alter the rank of the units proposed therein to suit his convenience.

¹ A. C. Smith, SCIENCE, 91: 572, 1940.

But, if this objection be received, it is then plain that there is not the slightest reason for preferring any monograph executed with "strict regard for the rules of botanical nomenclature and the type concept" to the usual supposedly imperfect texts by which priority is determined.

Behind Wheeler's proposal clearly stands the tacit assumption that modern perfection can take the place of age-old weakness, modern *names* thus having to be riveted upon the planks of history *per omnia saecula*. Behind this proposal also stands the belief that we can do something *to-day* that will last forever with slight probability of change. It is manifest that these assumptions disregard the historic and psychological angle under which science must be considered in any broad view of its needs and possibilities. These assumptions will elicit a smile on the lips of generations unborn which will wonder how it could ever come to the mind of somebody in 1939 that all that had been done before that year was neither perfect nor absolute.

Against hopes and attempts to seek certainty in science, be this certainty and its attending stability in the field of *concepts* or of *names*, must be stated aloud the truth that science is knowledge in organized evolution and part of man's live experience. As such, science must be accepted together with its attending evils and imperfection, everything about it being borne with patience and forbearance and—even more—with a mind open to the light that from time to time shines upon the path of the persistent inquirer.

Wheeler's preoccupation with stability is interesting as the symptom of a whole state of mind, which is much apparent to-day in the field of general botany. An almost morbid and ecstatic faith is being placed to-day in any formula, proposal or school of thought that promises "certainty" and assures of "stability." The success of the "typological approach" to morphology and to phylogeny in our midst is conditioned by this faith. It leads, as one would expect, to all the errors which always accompany a mystic and semi-religious approach to problems of knowledge.

LEON CROIZAT

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THE RATE OF SEASONAL DEPOSITION OF PEARL ARAGONITE

ALTHOUGH the formation of pearls represents an exceedingly interesting example of periodic biological function, analogous to the annual rings in trees, it has received little scientific attention. Except for a few restricted cases, not even the rate of growth of molluscs has been extensively investigated.¹

As a result of the writer's study, made in connection

¹ F. W. Weymouth, *Bull. Calif. Fish and Game Comm.*, 7: 120, 1923.

with the work of the Bureau of Natural Pearl Information, it was found that a number of natural pearls, when thin-sectioned, showed groups of laminae which are believed to represent seasonal growth. The data presented herein have been interpreted on that supposition. Between the major growth rings it is possible also to discern still other rings, of faint outline, which probably represent evidence of minor physiological changes that had taken place within the seasonal growth period.²

Two natural pearls in particular yielded valuable growth information. One, a fresh-water pearl of 6.12-grain weight, on thin-sectioning revealed measurements of the following order:

1st year's growth	2.30 millimeters
2d " "	0.38 " "
3d " "	0.46 " "
4th " "	0.27 " "
5th " "	0.35 " "
6th " "	0.32 " "
Partial 7th " "	0.04 " "

An annual average growth rate, after the first year and exclusive of the partial seventh, is 0.357 millimeter.

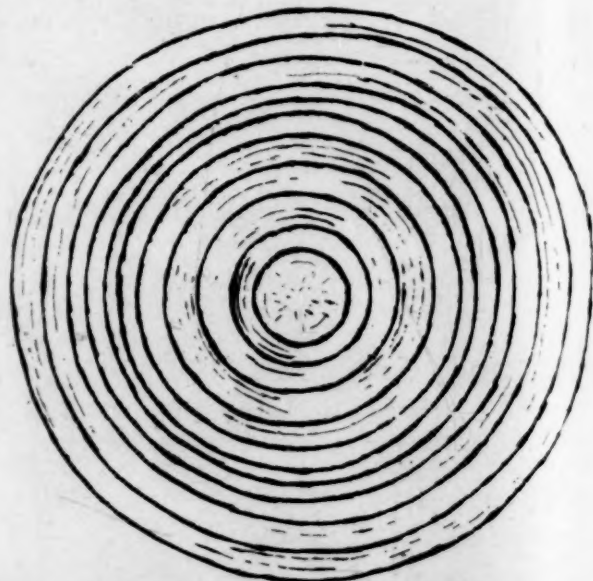


FIG. 1. Cross-section of a natural pearl, *M. margaritifera* (♀), showing seasonal growth rings (x 14).

The second pearl, of 3-grain weight, which had been taken from *Margaritifera margaritifera* (♀), disclosed eleven seasonal growth rings on thin-sectioning (Fig. 1). The growth measurements on this specimen were found to be as follows:

1st year's growth	1.60 millimeters
2d " "	0.18 " "
3d " "	0.18 " "
4th " "	0.18 " "
5th " "	0.13 " "
6th " "	0.14 " "

² A. E. Alexander, *Sci. Am.*, 160: 4, 228-229, 1939.

7th	"	"	0.15	"
8th	"	"	0.21	"
9th	"	"	0.12	"
10th	"	"	0.15	"
11th	"	"	0.15	"

The annual average growth after the first year is 0.159 millimeter. This particular natural pearl possessed almost perfect crystalline structure, both in the radial arrangement of the aragonite and in the concentric arrangement of the growth rings. This kind of pearl is not to be confused with the true oriental gem of commerce, and more properly should be classed as a calcareous concretion.

It should be kept in mind that the temperature of the water, the state of health and age of the mussel or mollusc, as well as the mineral content of the water, are but a few of the factors that determine how much calcium carbonate will be deposited and over what length of time. Also, the kind of irritant that initiated the secretion of aragonite is certainly another significant factor, because a sharp object of either organic or inorganic origin will most assuredly result in the rapid formation of mineral matter of a thickness that is commensurate with the degree of irritation originally set up within the pearl-oyster.³

In conclusion, it should be pointed out that many natural pearls, of either salt- or fresh-water origin, display no evidence of growth rings whatever. All the laminae of sub-microscopic thinness literally fuse into one another throughout the whole gem. This fact is not necessarily evidence of continual deposition, but perhaps represents ideal conditions of environment, coupled with perfect health on the part of the mussel or mollusc.

A. E. ALEXANDER

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THE "SMUT" DISEASE OF GLADIOLUS

We have recently been asked to investigate a core-rot disease of gladiolus corms. The somewhat dry brown rot extends from the base of the corm upwards and may follow laterally the vascular strands to the surface, ending in dark-brown sunken lesions. Moore¹ studied a similar disease in England and believed it to be caused by a species of *Botrytis*. Nelson² has also described a core-rot disease in Michigan. He attributes the disease to a species of *Fusarium*.

Among the fungi found associated with this core-rot disease in New York was one that we first thought to be *Urocystis gladioli*, the organism regarded as the cause of gladiolus smut. Wernham³ has recently re-

ported the first occurrence of gladiolus smut in the United States. He cultured the fungus isolated and observed that it could mature spore-balls readily in culture and that it was similar to *Urocystis cepulae* in the method of germination of the cells of the spore-balls. He, therefore, considered it to be a true *Urocystis*, probably *U. gladioli*. His figures would certainly suggest, however, that his fungus is a species of the form genus *Papulaspora*.

Smith,⁴ who originally described *Urocystis gladioli*, questioned, among other things, whether the fungus might not be a *Papulaspora*. He decided, however, that it must be a *Urocystis*, especially as Brefeld and Magnus, who examined his preparations, said that they believed the spore-balls belonged to a *Urocystis*. All those who have reported the fungus subsequently have also accepted this view, although Liro⁵ would place it in the smut genus *Tubercinia*.

In our cultures the bulbils or spore-balls, which are identical in appearance to those figured by Smith and by Wernham, are produced in abundance within a week's time. They are borne on lateral branches of the hyphae and originate from close spirals. The mycelial characters indicate very much an ascomycetous connection. In germination, the cells of the spore-balls send out hyphae directly, no intervening structure being formed which can be interpreted as a promycelium. On the corms masses of bulbils may develop superficially from a mat of mycelium which is sometimes found extending over the diseased areas; in no case, as was also noticed by Smith, were they found to be enclosed in a definite sorus membrane so characteristic of smuts. Furthermore, no one has proved by adequate inoculation experiments that the fungus previously called *Urocystis gladioli* can produce a smut disease.

In view of these facts, it is evident that further work on this organism occasionally found in connection with diseased gladiolus corms is urgently needed. Further studies of core rot will be reported elsewhere.

B. O. DODGE

THOMAS LASKARIS

THE NEW YORK BOTANICAL GARDEN

OCCURRENCE OF THE ORIENTAL RAT FLEA IN COLUMBUS, OHIO

THE oriental rat flea, *Xenopsylla cheopis* (Rothschild), is the most important species occurring in our fauna, due to its medical importance as a transmitter of bubonic plague and endemic typhus. Considerable attention has been given to its distribution and abundance in the United States. Originally found only in seaport cities, it is now known to occur in the interior of the country, having been reported from several of

⁴ Gard. Chron., 40: 420-422, 1876.

⁵ Ann. Univ. Fennic. Aboens. A.1: 1-153, 1922.

³ A. E. Alexander, *Am. Jour. Sci.*, 237: 920-922, 1939.

¹ *Min. Agric. Fish., London*, 117: 113-116, 1939.

² *Mich. Agr. Exp. Sta. Bull.* 149: 43-46, 1937.

³ *Phytopath.*, 28: 598-600, 1938.

the Central States. At the present time it has been reported to be permanently established only at Ames, Iowa.¹

Up to the present, the only record of this flea in Ohio is based on several specimens collected in Youngstown, reported by Ewing and Fox (1938).² Apparently no other infestation has been reported in the state.

In the winter and spring of 1940, several hundred specimens were collected from a feed box in the basement of the Botany and Zoology building at the Ohio State University. The fleas were apparently coming

in with the feed, which was procured from the University Farm, located across the river from the campus.

In the fall of 1940, an examination was made of 25 rats which were caught in the residential section of Columbus in the vicinity of the university campus. Fifty-one specimens of *Xenopsylla cheopis* were recovered from 18 rats, varying from one to six per rat. No other species of fleas were encountered. This information would seem to indicate that the oriental rat flea is probably established in Columbus.

A. G. RUNNER

OHIO STATE UNIVERSITY

SCIENTIFIC BOOKS

MATHEMATICAL ANALYSIS

A Course of Analysis. By E. G. PHILLIPS. viii + 361 pp. Cambridge: the University Press. 1939. \$4.00.

THIS text is an introduction to mathematical analysis based on the author's lectures to honors students in mathematics at the University College of North Wales. The reader is assumed to possess a working knowledge of the calculus, and the present treatment provides precise arithmetic definitions of most of the basic concepts, and a rigorous justification for many of the processes of the differential and integral calculus as applied to the functions of one or more real variables.

Of the included topics, besides those to be expected from their appearance in elementary calculus, the following deserve special mention. The discussion of the number system is preceded by a brief outline of Russell's definition of number based on logical notions. A well-written chapter on inequalities includes that of Jensen, as well as those of Hölder and Minkowski and a proof which illustrates the notion of "a best possible constant." Functions of bounded variation are discussed in connection with the rectifiability of plane curves.

Complex numbers are defined, and the possibility of extending a few results to them is mentioned. However, the author makes no attempt at any systematic treatment of complex values, not even defining $\sin z$. The limitation to real values seriously handicaps him in the treatment of Taylor's series and necessitates the omission of the justification for several expansions in Taylor's series which occur in the examples.

Definitions of the elementary functions for real values are given. That of $\log x$ and e^x in Chapter X is based on integration, while that of $\sin x$ and $\cos x$ in Chapter XII is based on power series. To provide enriched illustrations at an earlier stage, the author summarizes the properties in Chapter IV, referring ahead for the proofs, and stating that these functions will not be used in any general theorems forming the foundation of analysis.

¹ R. L. Roudabush, *SCIENCE*, 89: 79, 1939.

For the most part, the author sets himself and maintains a high standard of precision but the reviewer noticed a few exceptions. On page 72 and elsewhere in uniformity arguments he seems to imply that the $\eta(\epsilon)$ such that $|f(x') - f(x)| < \epsilon$ if $|x' - x| \leq \eta$ is uniquely defined. Again, several of the statements in section 4.2 on infinitesimals require revision. Finally in the theorem on functional dependence on p. 267 the conclusion that the functional relation is the same for all values is erroneous, as Bôcher pointed out.

In a few cases the statements of theorems are likely to mislead a beginner who fails to read carefully the notes in fine print interpreting them, as on pages 73 and 292.

The author's style is concise, and there are very few misprints.

The book provides an additional not too formidable reference for the student making his first acquaintance with rigor in analysis.

PHILIP FRANKLIN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE ENDOCRINE FUNCTION OF IODINE

Endocrine Function of Iodine. By WILLIAM T. SALTER. Pp. xviii + 351. Cambridge, Mass.: Harvard University Press. 1940. \$3.50.

THE text is divided into eleven chapters as follows: 1. Iodine balance and endocrine balance; 2. Iodine stores in body tissues; 3. Iodine compounds of biological importance; 4. Circulating iodine; 5. Thyroid activity; 6. Endocrine balance; 7. Iodine and the pituitary-ovarian axis; 8. Neurological influence; 9. Iodine balance; 10. Radioactive iodine; 11. Clinical problems. Eighty-five tables and charts are incorporated in the text.

The value of several of the chapters, particularly 2, 4, 7 and 9, depends on the critical analysis and evaluation of data obtained largely by microchemical methods for iodine estimations. These data in turn are dependent upon the accuracy of the methods used. The author is fully aware of the shortcomings of the best

² H. E. Ewing and I. Fox, *SCIENCE*, 88: 427, 1938.

microchemical methods at present available and also of the evolution of these methods during the last twenty years. Iodine values obtained during this period have in general progressively decreased as the methods have improved. Yet in these chapters older data are incorporated with the new. Thus the normal blood iodine is stated to be "rarely less than 5 micrograms per cent. or more than 20 micrograms per cent." Judged by the concentrations of other normal constituents of the blood, fasting normal blood iodine is probably more constant than present data indicate. The question always arises, Are we measuring only iodine? and the answer at present is that we are not. Such a question does not arise in the older work where only direct measurements of iodine were made, using material containing more than 100 micrograms of iodine per gram.

Chapter 10 on radioactive iodine is the outstanding chapter. It is an excellent summary of the work to date in this very recent and accurate application of a product of the cyclotron—"tagged" iodine, to the problem of the endocrine function of iodine. As work progresses, and it certainly will progress rapidly with "labeled" iodine, the bizarre normal values reported for iodine in the various tissues, using microchemical methods, will be checked by the more accurate microphysical methods and one may then expect that "normal" tissue iodine will be defined within narrower limits. At that time one may, perhaps, determine the iodine balance with the accuracy of a Ca, P or N balance.

The recent discovery by Hamilton and Soley that another product of the cyclotron-element 85 or "eka-iodine" is selectively taken up by the thyroid gland is properly emphasized. As the author points out, radioactive iodine gives investigators a fascinating new tool which should greatly improve the accuracy of future iodine determinations and thereby further extend our knowledge of the biological importance of iodine.

Chapter 8 is the poorest. There is no convincing evidence that the rich extrinsic nerve connections, both sympathetic and parasympathetic, play an important role (other than vasomotor) in thyroid activity; while against this there is an easily proven humoral factor, first demonstrated by thyroid transplantation, which the author does not mention, by cold and by *in vitro* tissue cultures. There are some minor clerical mistakes—as that Coindet reported on the treatment of goiter with iodine in 1811 and some confusing ones caused merely by the omission of "per cent." in the expression "mgm. per cent." (p. 100).

An appendix giving four methods in detail for estimating varying amounts of organic iodine, together with some of the general properties of iodine, materially increases the practical usefulness of the book. The sequential arrangement of the subject-matter has been well considered. A bibliography of 588 complete references and a good subject index complete the volume.

DAVID MARINE

SOCIETIES AND MEETINGS

INDIANA ACADEMY OF SCIENCE

THE fifty-sixth annual meeting of the Indiana Academy of Science was held on Thursday, Friday and Saturday, November 14, 15 and 16, 1940, at Muncie, Indiana, with Ball State Teachers College as the host institution. Over 400 scientists were in attendance.

The general meetings were presided over by Frank N. Wallace, state entomologist, and the principal papers on the general program were given by Glenn A. Black, Indiana State Historical Society, on "Archaeology at the Angel Mounds Site," and T. G. Yuncker, DePauw University, on "Life and Customs Among the Samoans." The necrology was read by Will E. Edington, DePauw University. The academy lost 18 members by death during the past year.

At the nine divisional meetings on Friday afternoon 104 papers were read.

The annual banquet was held on Friday evening, following which President Wallace spoke on "Fighting the Japanese Beetle in Indiana." This meeting

closed with the election of the following officers: *President*, Paul Weatherwax, Indiana University; *Vice-president*, Edward Degering, Purdue University; *Secretary*, Winona Welch, DePauw University; *Treasurer*, William P. Morgan, Indiana Central College; *Editor of the Proceedings*, P. D. Edwards, Ball State Teachers College; *Press Secretary*, Will E. Edington, DePauw University; *Divisional Chairmen*: Anthropology, Thomas B. Noble, Indianapolis; Bacteriology, C. G. Culbertson, State Board of Health, Indianapolis; Botany, R. E. Cleland, Indiana University; Chemistry, J. L. Riebsomer, DePauw University; Geology and Geography, Robert Karpinski, Indiana State Teachers College; Mathematics, Will E. Edington, DePauw University; Physics, R. E. Martin, Hanover College; Psychology, Harry N. Fitch, Ball State Teachers College; Zoology, W. E. Martin, DePauw University. R. E. Cleland, Indiana University, and Carl Means, Butler University, were elected fellows. The 1941 annual meeting will be held in Greencastle, Indiana, with DePauw University as the host institution.

The state societies of entomologists and taxonomists held their meetings on Saturday.

The Junior Academy, composed of 38 high-school science clubs, met on Saturday with 250 young scientists present. Addresses were given by Walter C. Geisler, Shortridge High School, Indianapolis, on "A New Technique in Gem Cutting," and L. S. Shively, Ball State Teachers College, on "Astronomy." Eleven papers were given by members of the Junior Academy. The following officers were chosen for 1941: *President*, Patricia Anderson, Edison High School, Hammond; *Vice-president*, Mary Hybarger, Lew

Wallace High School, Gary; *Secretary*, Mary Lou Sweet, Marion High School. Honorary memberships in the American Association for the Advancement of Science were awarded to Frances Scott, Arsenal Technical High School, Indianapolis, and Robert Gericke, Lew Wallace High School, Gary. Dean Howard E. Enders, Purdue University, senior academy sponsor of the Junior Academy, closed the meeting with a report on the progress of the Indiana Junior Academy through the state.

WILL E. EDINGTON,
Press Secretary

SPECIAL ARTICLES

APPLICATION OF N^{15} TO THE STUDY OF BIOLOGICAL NITROGEN FIXATION

STUDY of the mechanism of biological nitrogen fixation should be greatly aided if isotopic nitrogen could be used for tracing the path of nitrogen from its molecular to its fixed state in the cell. Inaccuracies of the Kjeldahl method have frequently suggested fixation of nitrogen by germinating seeds, *Rhizobium* independent of its host, non-leguminous plants and other biological agents whose ability to fix nitrogen is questionable. It would be possible to detect nitrogen fixation unequivocally, however, by the appearance of excess N^{15} in a biological agent under an atmosphere containing excess N^{15} , provided no direct exchange of N^{14} and N^{15} occurred between the fixed and the gaseous nitrogen in the system.

A culture of the free-living, nitrogen-fixing organism *Azotobacter vinelandii* was used to test for exchange. Nitrogen gas containing 35 per cent. N^{15} excess was mixed with air to produce a non-equilibrium condition of the molecular species of N_2 . This gas mixture was introduced into an evacuated culture vessel containing 30 ml of a three-day culture of *Azotobacter vinelandii* which had grown in air and fixed 117.7 micromols N_2 (as shown by Kjeldahl analysis). In four more days the culture fixed 150.2 micromols additional N_2 under the N^{15} -excess atmosphere. Samples of gas and culture were taken at the time the culture was first supplied with the N^{15} -excess atmosphere and at the termination of the experiment.

By assuming non-selective fixation and no exchange, it was possible to calculate (from the composition of the two atmospheres supplied to the culture and the Kjeldahl analyses) the final N^{15} content of the culture as follows:

	Micromols N^{15}
117.7 micromols N_2 fixed in air (0.37% N^{15})	0.43
150.2 micromols N_2 fixed in N^{15} -excess atmosphere (9.12% N^{15})	13.70
267.9 Total	Total 14.13

$$\frac{14.13 \text{ micromols } N^{15}}{267.9 \text{ micromols } N_2 \text{ fixed}} = 5.27\% N^{15}$$

Mass spectrographic analysis indicated a final concentration of 5.23 per cent. N^{15} in the culture.

The close agreement between the calculated and observed values indicates that there was no selective action in the fixation of N^{15} and N^{14} atoms from the molecules of mass 28, 29 and 30, and that there is no apparent exchange reaction between molecular nitrogen and fixed nitrogen in the culture. Schoenheimer and Rittenberg¹ have presented convincing evidence that the animal body exerts no selection between N^{14} and N^{15} in combined forms, but our study seems to provide the first direct extension of that observation to a biological process involving molecular nitrogen.

Analysis with the mass spectrometer indicated that initially the N^{15} -excess atmosphere contained 9.12 per cent. N^{15} and finally contained 9.11 per cent. N^{15} . The analysis showed the distribution of molecular species as in Table I.

TABLE I

Molecule		Concentration as percentage of total	
Composition	Mass	Initial	Final
N_2^{15}	30	2.99	3.01
$N^{15} N^{14}$	29	12.24	12.20
N_2^{14}	28	84.77	84.79

Calculations show that at equilibrium between the molecular species the distribution would have been as in Table II.

TABLE II

Molecule		Concentration as percentage of total	
Composition	Mass	Initial (9.12% N^{15})	Final (9.11% N^{15})
N_2^{15}	30	0.83	0.83
$N^{14} N^{15}$	29	16.58	16.56
N_2^{14}	28	82.59	82.61

Of the N^{15} -excess atmosphere supplied, 6.4 per cent. was fixed by the organism. If an equilibration (in-

¹ R. Schoenheimer and D. Rittenberg, *Physiol. Rev.*, 20: 218, 1940.

volving none of the nitrogen fixed in air) of the same magnitude as the fixation in the N^{15} -excess atmosphere had occurred, the distribution of molecules in the final atmosphere would have been: mass 30, 2.85 per cent.; mass 29, 12.50 per cent.; and mass 28, 84.55 per cent. These shifts are approximately eight times as great as the observed shifts in equilibrium.

If there had been an exchange between the fixed nitrogen of the culture, which was high in N^{14} from its initial period of fixation in air, with the nitrogen of the atmosphere, this would have been reflected in an approach toward equilibrium and in an increase in the molecular species of masses 28 and 29. If there had been a disruption of the N_2 molecules at the seat of fixation and a return of a portion of this nitrogen to the gaseous phase, the effect would have been evident merely as a shift toward an equilibrium condition.

It is evident, however, that the observed changes in the ratios of the molecular species are well within experimental error; and the lack of significance of these slight shifts is further emphasized by the fact that they are all away from equilibrium.

It is unlikely that an exchange reaction will interfere with the use of N^{15} as a tracer for studies of biological nitrogen fixation, but it would be well to test this point with each agent which gives evidence of positive fixation.

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SEASONAL FLUCTUATION IN ESTROGEN EXCRETION¹

SEASONAL periodicity in the lower animals is well known, but its recognition as a general principle applicable to the higher mammals has been slow. One of us (H. H. D., 1924, unpublished), experimenting with the pasteurization of cows' milk, found that the degree of separation of cream produced by a given rate of heating varied throughout the year, with a sharp change in the spring; not until 1938 was it shown (Ritzman and Benedict²) that the basal metabolism of the cow fluctuates seasonally. The data to be reported here have revealed a marked seasonal periodicity of estrogen excretion in the human female.

In April, 1939, in a series of pooled urines from young non-pregnant women, we found the surprisingly high estrogen content of 1350 I. U. per liter. An Ascheim-Zondek pregnancy test was done on the urine, with negative results. Since figures of this magnitude in the absence of pregnancy had not been observed

at other times of the year, a series of experiments was planned for a continuous record of estrogen excretion throughout the year. For this the cooperation of two normal women was obtained.

Owing to the difficulties of continuous collection of specimens, certain days were selected in each menstrual cycle to be tested. In Table 1 are given the results on subject F. A. for the months of August, January, February, March, April and May. It will be seen that January and February gave similar figures, which were markedly lower than those of the preceding August; there then followed a rise in March, and a much greater one in April, with a slight recession in May.

TABLE 1

DAILY EXCRETION OF ESTROGEN IN I. U. DURING VARIOUS MONTHS (Subject F. A.)

Day of cycle	Aug.	Jan.	Feb.	Mar.	Apr.	May
5	250	30	20	30	200	180
10	330	150	100	200	250	400
13	550	270	300	650	850	450
17	550	50	...	30	450	400
22	170	75	170	180	300	250
25	150	50	50	90	170	350
6 day total	2,000	625	> 640	1,180	2,220	2,030

Realizing the importance of a closer check on the spring rise, we had increased the number of specimens collected in March, April and May. Fourteen daily specimens in each cycle of 26 days were assayed during these months. The estrogen level was consistently higher in April than in March, whereas May readings were intermediate. The data are given in Table 2.

TABLE 2

DAILY EXCRETION OF ESTROGEN IN I. U. DURING THE SPRING MONTHS, 1940 (Subject F. A.)

Day of cycle	March	April	May
5	30	200	180
10	200	250	400
11	200	950	400
12	330	580	550
13	650	850	450
14	300	550	250
15	100	450	350
17	30	450	400
19	170	450	450
21	280	270	350
22	180	300	250
23	100	170	...
24	90	70	...
25	90	170	350
14 day total	2,750	5,710	> 4,080

The second case investigated gave a similar picture. The rise in March was not as striking as that in Subject F. A., but a large rise in April was recorded. Table 3 gives the results of this second case.

The above tables indicate that there is a marked seasonal fluctuation in the estrogen output of normal females. The human, from this evidence, is not exempt from those seasonal influences which operate

² National Research Council Fellow.

¹ This work was done under a grant from the Carnegie Corporation, New York.

² E. G. Ritzman and F. G. Benedict, "Nutritional Physiology of the Adult Ruminant," Carnegie Institution of Washington, Washington, D. C., 1938.

TABLE 3
EXCRETION OF ESTROGEN IN I. U. DURING VARIOUS
MONTHS, 1940
(Subject E. M.)

Day of cycle	Jan.	Feb.	Mar.	Apr.
5	50	30	20	500
6	110	120	100	750
10	230	350	380	100
15	40	20	150	200
20	220	75	200	180
24	70	20	120	
6 day total	720	615	970	> 1,730

elsewhere in the animal kingdom. It is more than ever difficult to state, unless the annual fluctuations are taken into account, what is the normal output of estrogen by a woman.

A more detailed report of this investigation will be published shortly in *Endocrinology*.

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THE EFFECT OF TYROSINASE ON ARTERIAL HYPERTENSION

BECAUSE the substance responsible for some varieties of arterial hypertension may be a simple amine, particularly one containing a phenolic group, a pure preparation of tyrosinase, a phenolic oxidase obtained from mushrooms by Dr. J. M. Nelson, was used in animals exhibiting "renal" hypertension. It was found that tyrosinase is effective in lowering raised arterial pressure in rats and dogs when their kidneys are injured.^{1,2} The pressor substance may accordingly contain a phenolic group.

Further evidence for this theory was obtained by ascertaining the effect of tyrosinase upon certain pressor substances. It was found that renin is inactivated by tyrosinase when catechol is present—probably through the mediation of the orthoquinone formed. Angiotonin, obtained from Dr. Irvine H. Page, is also inactivated by tyrosinase when serum is present, suggesting that angiotonin, in its active state, contains a phenolic configuration in the molecule. The pressor substance obtained from the anaerobic autolysate of kidneys, prepared by Dr. Joseph Victor, is inactivated directly by tyrosinase, as is, of course, adrenalin and tyramine.³

Since the results in animals were satisfactory, it appeared necessary to ascertain the effect of this enzyme upon hypertension exhibited by human beings.

¹ H. A. Schroeder, *Proc. Soc. Exp. Biol. and Med.*, 44: 172, June, 1940.

² H. A. Schroeder and A. E. Cohn, *Jour. Clin. Inv.*, 19: 769, September, 1940.

³ H. A. Schroeder and M. H. Adams, "The Effect of Tyrosinase on Experimental Hypertension" (to be published).

Seventeen patients suffering from arterial hypertension have been treated by daily subcutaneous injections of varying amounts of tyrosinase for three to four weeks. In fourteen the systolic pressure had been persistently above 200 mm Hg and the diastolic above 120. In all but one the blood pressure fell a significant amount; in seven to 140 to 160 mm Hg systolic, and 80 to 100 diastolic, and in six to 160 to 180 systolic and 100 to 115 diastolic. In the other three, the response was less. Three patients in a late stage of the disease were improved. In one there was no effect.

The fall in blood pressure was accompanied by certain other changes, indicating that a general effect upon the disease had occurred. In seven patients whose electro-cardiograms were altered a change in the direction of normal occurred. In three the hearts became small as observed in x-ray photographs. In all but one the level of the urea nitrogen in the blood was lowered, but the clearance of urea was unaffected. Symptoms, when present, were relieved. In four, hemorrhagic and exudative lesions were present in the eyegrounds. These disappeared. No change in the ability of the kidneys to concentrate urine was observed.

When injections of tyrosinase were stopped, the blood pressure soon (within three to six days) returned to its previous level. Symptomatic improvement, as well as the improvement in the ocular fundi, lasted for several weeks or months.

Injections were painful at times; at others no discomfort occurred. Occasionally a moderate degree of pyrexia followed the injections. Allergic reactions at the site of injection developed in three patients.

On one occasion a small amount of enzyme was given intravenously. This was followed by a severe reaction, with nausea, vomiting, signs of increased peristalsis, fall of blood pressure and bradycardia. The blood pressure remained low for twenty-four hours afterward. Significant decrease in the clearance of urea did not occur. Although the blood pressure fell from 220 mm Hg systolic and 150 diastolic to a level of 130 systolic and 90 diastolic for this period, the patient remained comfortable.

Relatively large doses were needed when given by the subcutaneous route. Since the enzyme is a protein, it is doubtful whether absorption was complete. Deposition of grey or yellow pigment at the site of injection was a common occurrence.

It is evident that subcutaneous injections of tyrosinase effectively but only temporarily lower blood pressure in certain cases of arterial hypertension in human beings. These results suggest that some phenolic substance is altered.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF FREEING SEA WATER OF PHOSPHATE

In the analysis of sea water for phosphate by the Deniges colorimetric method,¹ the effect of the dissolved salts upon the color development is appreciable and should not be disregarded.² Although the standards may be prepared in distilled water and the apparent results multiplied by a correction factor, it is better to make the standards in a salt-water medium and eliminate this correction. Inasmuch as sodium chloride is the main constituent of the dissolved salts in sea water, a sodium chloride solution is sometimes utilized as a synthetic sea water. There are a number of disadvantages involved in so doing. The commercial C. P. sodium chloride invariably contains phosphate as an impurity, different lots of sodium chloride even from the same company seldom contain the same amounts of phosphate and usually it is present in an amount which makes necessary the application of an undesirably large blank correction. Also such standards become very expensive when used for routine work. Furthermore, it has even been asserted that the "salt effect" of sea water is not due to the main dissolved constituents but to small amounts of copper.³ Although this has been questioned,⁴ it is obvious that the best medium would be phosphate-free sea water itself.

Certain pelagic forms, mainly diatoms and algae, extract phosphate, nitrate and other nutrient substances from the sea. When conditions are suitable the growth of these forms may be sufficient to remove completely these nutrients unless the supply is replenished from the rich lower waters through turbulence or upwelling. Because of constant replenishment the waters of Puget Sound region as well as those along the Washington coast are very rich in nutrients at all seasons of the year. It is only in isolated inlets and estuaries that the phosphate is diminished appreciably by the diatom "flowering" and then seldom entirely removed. Consequently, the supply of phosphate-free water from this source is uncertain.

A far more certain and convenient method of acquiring phosphate-free sea water has been to grow these pelagic forms in glass bottles or carboys containing sea water. In a number of cases the growth of the normal plankton population has been sufficient to effect the phosphate removal. A better procedure

has been to enrich the water with added plankton and in such cases the phosphate has been quickly removed.

Table 1 contains the records of a series of samples

TABLE 1
REMOVAL OF PHOSPHATE FROM SEA WATER BY PLANKTON

Mg. at. NO ₃ -N per liter	uga. PO ₄ -P per liter				
	0 days	1 day	2 days	6 days	9 days
0.04 + 0.00	1.45	0.93	0.32	0.24	0.00
+ 0.88	1.45	1.09	1.13	0.34	0.00
+ 1.47	1.45	1.00	1.20	0.37	0.00
+ 2.06	1.45	1.35	2.05	1.70	0.00
+ 2.94	1.45	0.75	0.55	0.30	0.00
+ 4.40	1.45	0.97	1.63	0.37	0.00
+ 5.88	1.45	0.57	0.93	0.24	0.00
+ 8.82	1.45	0.97	0.85	0.00	

Note: Mg. at. or milligram atom is equivalent to gram atom $\times 10^3$.
uga. or microgram atom is equivalent to gram atom $\times 10^6$.

treated in such a manner. Eight two-liter samples of water which had been collected from the bay at Friday Harbor on an incoming tide were placed in glass bottles. Plankton, mainly diatoms, was collected with a hand net from the bay and aliquot portions were added to each of the samples. Additional nitrate was added to insure that it would not be a limiting factor in the plankton growth. As it was possible that there might be some optimum nitrate concentration other than that naturally occurring in sea water, nitrate was added to the samples in varying amount to test this effect. The temperature and light conditions were not controlled except that the samples were kept in the shade and exposed only to diffuse light. Every few days the bottles were shaken vigorously to eliminate stratification and a fifty milliliter sample of water was taken from each bottle for analysis. Suspended plankton was removed by filtering through filter paper. The analysis was made in the normal manner using the Zeiss-Pulfrich Gradation photometer for the colorimetric estimations.

In all cases the removal of phosphate was completed in six to nine days. Apparently the addition of nitrate was without effect. As indicated in Table 1 there was a general decrease in the phosphate concentration with time though there was an occasional increase. Increasing phosphate concentration is attributed to bacterial action. In the transference of plankton from their natural habitat to the bottled sea water many naturally died. These were acted upon by the bacteria present resulting in liberation of phosphate. When phosphate liberation by bacteria was more pronounced than phosphate utilization by the plankton the phosphate content of the water naturally increased. This was only a temporary effect as these samples likewise became free of phosphate. However this does emphasize the necessity of the removal of the plankton by filtration

¹G. Deniges, *Comptes rendus hebdomadaires des seances de l'Academie des sciences*, 171: 802-4, 1920.

²Rex J. Robinson and H. E. Wirth, *Indust. and Eng. Chem., Anal. Ed.*, 7: 147-150, 1935.

³K. Kalle, *Annalen der hydrographie und maritimen meteorologie*, 63: 58-65, 1935.

⁴L. H. N. Cooper, *Jour. Marine Biol. Assn. of the United Kingdom*, 23: 171-8, 1938.

immediately after the samples become phosphate free as the plankton naturally died by starvation and regeneration of phosphate through bacterial action is likely to occur.

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AN IMPROVED METHOD FOR DETERMINING THE PRESENCE OF THE VIRUS OF ANTERIOR POLIOMYELITIS IN STOOL SPECIMENS

IN a previous paper¹ a modification of the current technic^{2,3} for destroying the pathogenic bacteria in stool specimens from patients with anterior poliomyelitis was described. Also the fact was noted that virus in stool had remained infectious after 124 days at a temperature of approximately -5°C .

With the previous procedures as a basis, a new technic has been developed which seems to be a marked improvement. Stools are collected in the field in collapsible stiff paper containers and transferred to sterile bacteriologic water bottles with ground-glass stoppers. An attempt is made to collect two or three specimens from each patient, taken on alternate days. No specimens are accepted if a cathartic has been given recently. On receipt at the laboratory they are stored at -5°C .

In the laboratory, samples of all the specimens from each patient, totaling from 15 to 20 ml of solid stool are diluted in from 150 to 200 ml of water and are thoroughly broken up. To this suspension enough "Duponol" WA (flakes)⁴ is added to make a 0.50-per cent. solution. The stool-Duponol suspension is then shaken three minutes by hand with from 15 to 20 ml of ethyl ether and is stored in the refrigerator at 8°C for twenty-four hours. At the end of this time, the usual bacterial flora (coliform bacilli, cocci and most of the spore-formers) fail to grow on nutrient agar. The ether is then boiled off under the vacuum from an "air-jector" aspirator and the material is ready for inoculation. The sediment in the bottom of the bottle is shaken into suspension and from 12 to 15 ml are injected intraperitoneally into a rhesus monkey. If, on the second day after the initial inoculation, the monkey's temperature is normal, the same quantity is again injected.

Five separate experiments have been made, with as many different stool specimens, all from cases of clinical poliomyelitis. In the first, only 0.25-per cent. Duponol was used, and the stool was not completely

free of viable bacteria after forty-eight hours and two treatments with ether. The specimen, however, did infect a monkey, with resulting paralytic poliomyelitis and typical pathologic changes in the central nervous system. The virus was passed a second time.

The second two specimens were also treated with 0.25-per cent. Duponol and ether, and re-treated with ether over a period of ten days. Not only were they not free of viable bacteria at the end of this prolonged treatment, but they failed to infect monkeys with clinical anterior poliomyelitis.

In the last two cases, 0.50-per cent. Duponol was used. After eight hours' treatment with ether, samples of the stools incubated aerobically on nutrient agar showed only a few colonies; after twenty-four hours' treatment with ether, no colonies developed. Both monkeys inoculated with these treated specimens contracted paralytic anterior poliomyelitis. In each case, the diagnosis of anterior poliomyelitis was substantiated by the microscopic examination of tissue removed at autopsy.

It is of interest that the pH in infective stools, as determined by colorimetric methods and checked with a glass electrode, ranged from pH 6.6 to pH 7.4. The final surface tensions before inoculation as measured on the DuNuoy tensiometer ranged between 32.7 and 37.8 dynes per centimeter.

It is suggested that, since this method involves such a simplified technic and permits large doses of stool to be given, it may prove useful in laboratory investigations in connection with epidemiologic studies. Such work is in progress in this laboratory.

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BOOKS RECEIVED

- Carnegie Foundation for the Advancement of Teaching: Thirty-fifth Annual Report, 1939-40.* Pp. 170. The Foundation.
- Council for Scientific and Industrial Research. Studies of the Physiology and Toxicology of Blowflies.* No. 101, pp. 131. Illustrated. No. 102, pp. 67. Illustrated. The Council, Melbourne.
- HERING, DANIEL W. and others. *Time and Its Mysteries: Series II; Lectures given on the James Arthur Foundation.* Pp. viii + 137. New York University Press. \$2.00.
- Science, Philosophy and Religion; a Symposium.* Pp. viii + 443. The Conference on Science, Philosophy and Religion in Their Relation to the Democratic Way of Life, Inc., New York. \$1.50.
- SMITH, GEDDES. *Plague on Us.* Pp. 365. Illustrated. Commonwealth Fund, New York. \$3.00.
- Tôhoku Imperial University, Science Reports.* November 1940. Fourth Series (Biology). Vol. XV, No. 4. Pp. 357-480. Illustrated. Maruzen Co., Tokyo.
- Zoologica: Scientific Contributions of the New York Zoological Society, December, 1940.* Pp. 369-570 + viii. Illustrated. The Society, New York.

¹ G. Y. McClure. To be published in *Jour. Lab. and Clin. Med.*

² J. D. Trask, A. J. Vignee and J. R. Paul, *Jour. Am. Med. Assn.*, 111: 6-11, 1938.

³ S. D. Kramer, B. Hoskwith and L. H. Grossman, *Jour. Exper. Med.*, 69: 49-67, 1939.

⁴ A sodium laseryl sulfate manufactured by E. I. du Pont de Nemours and Company, Inc.